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OBSERVATIONS UPON THE HABITS, STRUCTURE AND DEVELOPMENT OF AMPHIOXUS LANCEOLATUS.

BY HENRY J. RICE.

PREVIOUS to last season, specimens of that very curious fish-like animal, *Amphioxus lanceolatus* Yarrell, had been discovered along the eastern coast of the United States only in Florida and North Carolina, and one specimen, according to Mr. P. R. Uhler, president of the Maryland Academy of Science, upon the Eastern Shore of Virginia. While engaged in laboratory work at the Chesapeake Zoölogical Laboratory, at Fort Wool, last summer (1878), I was fortunate enough to obtain possession of three adults—two males and a ripe female—and twenty specimens of the young of this very interesting species, thus making Fort Wool not only a new locality for the adult animal, but, so far as I am aware, the only place in America where the young have ever been captured.

Of these specimens the adults were taken with the dredge from the bottom of the bay, south and east of the fort, in a depth of water of from twelve to fifteen feet, and the young were secured by surface dredging with small hand-nets of bolting cloth, from around the wharf, and near the steps of the boat-landing. While they remained alive, which was during the greater part of the months of July and August, I had the opportunity of making a very interesting series of observation, in regard to their habits, and those peculiarities of structure and development which have drawn so much attention to this animal, and rank it as at least the lowest of vertebrates, if not an intermediate type between Vertebrata and Invertebrata. These investigations, the results of which

I have embodied in the following necessarily incomplete summary of our present knowledge of Amphioxus, were conducted with a great deal of care, and while they have led me to differ from the commonly received views in regard to certain particulars of structure and development, they have enabled me, by a somewhat detailed comparison of results, to corroborate much of what has already been done in this important field of research.

History.—This apparently insignificant little creature was first made known to science, in the year 1778, from specimens found upon the coast of Cornwall, England, and sent to Peter Simon Pallas, a celebrated German naturalist, who was then issuing his Record of new forms of animal life. The description given in this Record[1] is, in the main, quite accurate, but from some misunderstanding of the nature of the ventral ridges, or perhaps from some slight resemblance to a sea-slug, Pallas considered it a new species of snail, and named it *Limax lanceolatus.* Had he had the opportunity of examining other than contracted specimens of this new form, he probably would not have written, "Tentacles evidently none," and might have hesitated before placing it among the Limacidæ. But if Pallas failed to correctly estimate its generic features, the next writer who mentions it[2] seems to have been able to appreciate them to a certain extent, for he remarks, that it is "hardly a Limax," although for some reason he retained this name, and adds to it, probably through some typographical error the specific term of *lanceolaris*, which ought only to accompany the genitive of Limax, or Limacis. After this notice by Stewart, *Limax lanceolatus* seems to have dropped from the vocabulary of zoölogists and to have passed almost from the memory of those engaged in describing and classifying new species of animals, for in 1834, when Costa[3] discovered this same animal in the Bay of Naples, Italy, he failed to recognize it as having been described before, and considering it a new species of fish, he named it *Branchiostoma lubricum*, from the fact of its having tentacles about the mouth, and upon the supposition that these tentacles subserved the purposes of respiration as branchiæ.

[1] Spicilegia Zoölogica. Peter Simon Pallas. Fasc. x, p. 19. Taf. 1, Fig. 11. Berlin, 1778.

[2] Elements of Natural History. —— Stewart. 2d edition. Vol. 1, p. 386.

[3] Cenni Zoölogici ossia descrizione sommaria di talune specie nuove di animali. O. G. Costa. Page 49. Napoli, 1834. And, Storia el *Branchiostoma lubricum.* Napoli, 1843.

Almost simultaneously with this discovery of Costa, it was rediscovered upon the coast of Cornwall by Mr. Couch, and was recognized by Mr. Yarrell as the *Limax lanceolatus* of Pallas. But Mr. Yarrell also recognized as Costa had already done, and thus corroborating the doubts of Stewart, that instead of being a Limax it was, in reality, closely allied to the class of fishes, and not aware of its discovery in Italy, by Costa, he erected a new genus for it, *Amphioxus* (*Amphi*, on both sides, and *oxus*, sharp, from the fact that both extremities are pointed), and described it in 1836[1] as *Amphioxus lanceolatus*. It will thus be seen that the generic name assigned it by Costa has priority over that instituted by Yarrell, but the term Branchiostoma being founded upon a misconception of the functions of the tentacles, and the specific name of Pallas having priority over all, the name as given by Yarrell, *Amphioxus lanceolatus*, has come, by common consent, to be adopted as the appellation of this small denizen of the sea. Since 1836 Amphioxus has been found inhabiting nearly every quarter of the globe, specimens having been taken in China, Borneo, South as well as North America, and along the entire coast of Europe, although it has been found most abundantly in the waters of the Mediterranean sea, near Naples and Messina, Italy, where at present the conditions seem to be most favorable for its propagation and growth.

These various specimens, coming from such widely separated localities, were supposed, by their discoverers, to represent distinct species of this animal, and specific names have accordingly been given them, as *Amphioxus belcheri* Gray, for the East Indian form, and *Branchiostoma caribæum* Sundeval, for the form upon our coast, but the best informed European systematists consider that all these forms represent but a single species,[2] the *A. lanceolatus* Yarr., of Europe, which thus becomes one of the most widely distributed, as it is certainly one of the most anomalous of existing animals.[3]

[1] Hist. of Brit. Fishes. Wm. Yarrell. Vol. II, p. 468. London, 1836.

[2] Traité de Zoölogie. Page 808. Paris, 1878. Translated by Prof. G. Moquin-Tandon from the third and latest edition of the Handbuch der Zoölogie of Prof. C. Claus.

[3] Dr. Gill, of the Smithsonian Institution, informs me that Sundeval separated the Caribæan form from that of Europe on account of a difference in the number of plates, or fibers in the muscle-plates, of one form from that of the other. I have not as yet been able to examine the two forms with a view to determine this point.

General Description and Habits.—The adult Amphioxus, Fig. 1, Pl. 1, is a small, rather slender animal, which lives for the greater part of the time entirely buried in the sand along the sandy portions of the shores which it inhabits. When fully grown it is about two inches in extreme length, rarely somewhat longer, and of a pale flesh color which changes, when seen by reflected light, to a beautiful display of metallic iridescence.

Its body is smooth, very muscular, much compressed from side to side, and tapers gradually to the extremities, which are pointed, but differ considerably in contour, for while the posterior is lance-shaped, from whence is derived the specific name of *lanceolatus*, the anterior is formed like the ram of a modern gun-boat, and is admirably well adapted for forcing a way through the sand in which it burrows. The abdominal portion of this blade-like structure forms a dilatable sack which extends from near the anterior end of the body back for about two-thirds the entire length of the animal, where it terminates in an opening, the abdominal pore or branchiopore, which places the cavity enclosed by the sack in communication with the exterior. During the life of the animal this abdominal sack is seen dilating and contracting quite regularly, although at rather lengthy intervals, with a wave-like motion which begins at the forward end of the cavity and travels backward, rather slowly, to the posterior extremity. When the sack is completely distended this portion of the body presents a full, clear, rounded appearance, and projects considerably below the ordinary ventral outline, but when contracted, as it is in all preserved specimens, all appearances of a cavity disappear, leaving merely a slight indentation where the "pore" is situated, between the abdominal and the tail portions.

Through the center of the muscular part of the body, and forming an axial support to the animal, there is a long, slender, semi-cartilaginous rod, which is pointed at each end, and which extends from the very point of one extremity to that of the other. This rod is composed of an external membraneous sheath enclosing a series of closely approximated flattened disk-like bodies, and is probably the homologue of the vertebrate notochord, or backbone, although not exhibiting any anterior cranial expansion. Above it, but not extending quite as far forward, is the main nervous system, or chorda dorsalis, and below it lies the long, nearly straight alimentary canal. This canal opens anteriorly by a longitudinal

aperture, the mouth, placed upon the median, ventral line just behind the depressed ram-like termination of the body, and between it and the anterior portion of the abdominal cavity. This oral opening is of moderate size, and is surrounded by about thirty-one tentacles which are moderately long and slender, and bear upon their sides little protuberances which give them a toothed appearance. The anus, or outlet of the canal, is funnel-shaped, and opens very eccentrically upon the left side of the body just beneath the level of the notochord and *quite* near the end of the tail. The left or free edge of this aperture does not extend at its posterior limits quite down to the ventral edge of the muscle-plates, so that the anus also opens, to a certain extent, *towards* the left side of the body, although the fœces are expelled directly backwards and downwards along the side of the median fin. This free edge is quite flexible and in hardened specimens is so contracted, together with the surrounding parts, that the anal aperture appears to open into a pseudo-cloaca. The integument, which forms the greater part of the mouth tentacles, is thin and nearly transparent, and expands along the entire length of the dorsum, and around the tail, and as far forward as the branchiopore, into a delicate, median fin of nearly uniform width except upon the edges near the posterior extremity, where two unequal lobes are formed which represent the blades of this "lance" termination. Of these two "blades" the ventral is the larger, and its posterior curvature is nearly below the anal opening of the intestine. The integument also forms two longitudinal folds, which extend along either side of the abdomen, from the posterior portion of the mouth orifice where they originate, to the indentation which exists between the abdominal and the tail portions. Here, after forming a sort of triangular pit into which the branchiopore opens, they become merged into the median, ventral fin, which, as already stated, reaches forward to this point. When the abdomen is fully extended these folds become nearly obliterated, and are barely visible as lines running along the sides parallel to and at some distance above the ventral outline; but when the abdomen is strongly contracted they form prominent ridges along the lower edge of the body, and so change the appearance of the specimen that it is not much to be wondered at that Pallas should say, that this portion looked "very much like the very narrow foot of a snail."

These folds are hollow and have been thought, until quite recently, to have an opening at either extremity, but Prof. Ray Lankester denies[1] that there are any such openings, and I have failed to obtain any evidence from my specimens that any such apertures exist. With the exception of these side-folds and the mouth tentacles, the integument presents no appendages whatsoever. External sense-organs are also wanting, except upon the left side of the body near the anterior end of the chorda dorsalis, where a small ciliated pit is said to be located which it is claimed, by Kölliker,[2] its discoverer, and others, represents a nasal depression, or cavity. I have not been able to make out this pit, and even if it is present, it is probable, that these animals gain their impressions of external objects entirely by the general sense of touch.

The adults, while varying somewhat in size, as is the case with most adult animals, do not differ very much otherwise in general appearance except during the breeding season, when the female becomes filled with ova, and the abdominal portion becomes, in consequence, much larger than ordinary. At this period the ova show very plainly as a row of large white spots along either side of the animal, Fig. 1, Pl. 1, but at other times, and in the males, there are no such spots visible to the naked eye. These differences of size and sexual appearance were well marked in my specimens, for while they varied in length from $1\frac{1}{16}$th to $1\frac{7}{16}$th inches, thus being of rather small size, the female, which was the largest, was so distended with ova that her body was much rounder, and consequently more opaque in appearance than the bodies of the thinner males. The young, Fig. 5, Pl. 1, and Fig. 7, Pl. 11, resemble the adults very much in outline, but differ in many points of structure, which will be noticed in treating of their development, and in being quite transparent, looking much like animated bits of isinglass when in the water. This transparency, however, gradually gives place, as they grow old, to a semi-opaque condition which permits the outline of different parts to be made out, but not with any great degree of distinctness unless under a very strong light, and the older and larger the specimen, as a matter of course, the less the distinctness. The young specimens varied in length from $\frac{5}{64}$th to $\frac{5}{16}$th of an inch, although the greater number were about $\frac{2}{16}$th of an inch long.

[1] On some new points in the structure of Amphioxus. Prof. E. Ray Lankester. Quar. Jour. of Micro. Science. Vol. 15, p. 257, 1875.

[2] Müller's Arkiv, p. 32. Berlin, 1843.

All of the above-mentioned specimens which came into my possession, were gathered together during the period from the 9th of July, when the first specimen, an adult, was obtained, to the 2d or 3d of August, after which date no more could be found. The young were taken mostly at night, one or more at a time, when the water was comparatively quiet, but the greatest number captured on any one occasion was at noon of a very hot day, when there was scarcely a breath of wind, and the surface of the bay was almost as smooth as the proverbial "sheet of glass;" these small inhabitants thus seeming to be affected by heat, and especially by a quiet condition of the water, in very much such a manner as are the myriads of other young animals which are floated hither and thither by the currents of the sea at this season of the year. As soon as taken they were transferred to tumblers which had been previously filled with fresh sea-water, and each tumbler was generally occupied by four or five specimens. The water was changed daily in all the vessels. When first placed in these receptacles they darted about with a quick "wiggling" motion which resembled somewhat the movement of a tadpole, but different in that the head, or anterior part of the body, moved from side to side as far and as vigorously as the tail portion. This peculiar undulation was generally kept up for some little time at or near the surface, when suddenly they would cease all motion and allow themselves to sink slowly to the bottom, where they would remain flat upon their sides until again impelled to action. When this impulse came, from whatever cause, and they were once started from their resting place at the bottom, they generally swam directly upward to the surface, moved about here for a short time, and then, as before, suddenly stopped and allowed themselves to sink again to the bottom. But sometimes one of the inhabitants of a dish would start up, seemingly impelled by some willful freak, dash about close over the bottom and stir up all the others in the vessel, when there would be, for a moment or so, quite a brilliant display of undulating, flashing forms.

The largest of these young specimens was pretty well advanced in development, and was placed in a separate dish which had a layer of sand upon the bottom. It was thus isolated for the purpose of ascertaining if it would make use of the sand as a place of refuge, but only on one or two occasions, and then for very

brief periods, did it ever disappear beneath the surface. Generally it lay flat upon the top of the sand, until disturbed from its repose, when its actions closely resembled those of its smaller fellows. Hence it must be at a later period of life than that to which this one had attained, that these little animals cease to be shifted about by the flood and ebb of changing currents, and become "burrowers." The adults, which were taken from the banks by means of the dredge, were placed together in a large jar of sea-water, which was furnished, like the dish of the largest of the young animals, with a layer of sand upon the bottom. When once in the water they commenced swimming about very rapidly, with the same graceful, undulating motion which has been noticed as characteristic of the young, but with much greater vigor and elasticity. These movements were executed sometimes upon the back, sometimes upon the abdomen in the position of ordinary fishes, it seemed to make very little difference which side was uppermost, but I have never seen them move backwards, or tail-end foremost. After circumnavigating the vessel once or twice, gradually moving slower and slower, they would stop and sink down upon the sand at the bottom. Generally as soon as they touched the sand they would half-arch their bodies and almost instantaneously disappear from sight beneath the surface, thus regaining their natural place of refuge. After this disappearance they very rarely entirely emerged from their retreat, and as a rule, not at all during the day time. But if the surface of the sand was carefully examined at night, little spots might be detected where the sand appeared less compact than elsewhere, and a close inspection would discover each such spot to be a network of crossing tentacles arching over the expanded mouth cavity of one of these animals, which was thus, while lying belly upwards buried in the sand with only its mouth exposed at the surface, busily engaged in drawing its food from the water above.

Sometimes they could be found so situated during the day time, and now and then both by day and night, but rarely in the day time, one or more of them could be seen protruding part way from the sand, and looking as if planted in this position, but a tap or a motion of the vessel would cause them to withdraw from sight immediately.

These actions would seem to indicate what is probably a fact,

that the day time is to these animals a period of rest, when they remain entirely buried beneath the surface, and night time a period of activity, when they come up to feed and perhaps to move from place to place, as they have been seen swimming about during the night in the aquarium at the Zoölogical Station at Naples, and on one or two occasions I have found, early in the morning, one of my specimens lying entirely out of the sand, fully exposed to view, and in all probability it had been swimming about during the night.

On account of the propensity of these animals to remain concealed from sight it was necessary, whenever they were wanted for examination, to drive them from the sand, and this was by no means an easy task, as they are such exceedingly active little beasts that they would work their way from side to side of the dish beneath the sand, very nearly as quickly as I could run a stick or pencil through it in trying to find their position. And when once forced out, they would dart through the water so impetuously, and plunge into the sand again so quickly that their movement seemed merely a flash in the water, and a few particles of floating sand and mud would alone indicate that one of them had been out of their proper domain. Generally this chasing process had to be repeated four or five times, when they would become exhausted, and after undulating about the jar very slowly for a moment or so, they would sink upon the sand and remain perfectly quiet, flat upon their sides, for sometimes half a day at a time. During these intervals they could be transferred from dish to dish and even placed under a low power of the microscope for examination. But if not completely exhausted a short rest would revive them, and then, when touched, they would dash away as impetuously as ever, and I have had them, on such occasions, rush out of the water and over the broad rim of a large plate on to the table, and before they could be touched, much less secured, throw themselves off the table and down upon the floor. But the adults appear to be so vigorous that these falls, which occurred on two different occasions, did not seem to have the least injurious effect. As may be surmised from this, all their movements are exceedingly quick, and this rapidity in going through sand and water, and hence the ease with which they can move about from place to place, is probably the reason why we secured only three of these animals at Fort Wool.

We made a large number of dredgings but the dredge used was too coarse and heavy for such work, and as we had had no idea of finding Amphioxus at this place, we were unprovided with one of suitable construction. It is probable that with a proper dredge, perhaps a ring dredge, made light and with fine meshes, they could be taken in this locality in fair numbers, and it is possible that places might be found along our coast, if searched for, where they could be taken in as great abundance as at Naples and Messina, in Italy. And where the adults are found the young could be taken also, if looked for during the breeding season, which in this country is probably during the months of June and July. I base this statement upon the facts that my young specimens, which were somewhat advanced in development, were taken mostly during the second and third weeks of July, and that only one specimen could be secured after the close of that month. Amphioxus does not appear to be a difficult animal to keep if supplied with plenty of sand in which to burrow, and a daily change of water of a density equal to that which is found at the place of its capture, My adults remained alive and appeared to be in fine condition as long as I could give them water which came in fresh from the sea every day, but in September they were carried up the bay to Tangier's sound. where being unable to supply them with suitable water they soon showed unmistakable signs of debility, and on the 10th inst. they were placed in picric acid to be ready for future service. None of the young remained alive as long as did the adults, and only a few grew so well and appeared so vigorous as to indicate that they would reach maturity. Some of them, from some cause, became dwarfed and drawn out of shape so as to look, in one or two cases, like a large letter S, and others, probably from the erosive or wearing action of bits of sand, or something of the kind, which had entered the stomach and intestines along with the food, had lost portions, and sometimes half of their bodies, and yet these little deformed and maimed animals lived sometimes for a week in such condition, evincing certainly a good degree of vitality, and enabling us, if Amphioxus is really one of the earliest of animals, the better to appreciate the "why and the wherefore" of the persistence of this species to present time.

The Skeleton.—The framework of Amphioxus is entirely cartilaginous, and is composed of the notochord; a series of processes

said to represent spinous processes, which extend along nearly the entire length of the dorsum, and along the ventral side of the tail portion of the animal; and a series of arches or supports which are formed along and in the sides of the anterior half of the alimentary canal. The *notochord* has already been described, and its position defined as forming an axial support extending from end to end of the body, and representing the back bone of higher vertebrates, but lacking the anterior expansion or brain case. The *spinous processes* form rows of semi-transparent, perpendicularly placed, block-like bodies; the dorsal row originating over the chorda dorsalis, and rising upwards from between the side muscles to form a median basal support to the dorsal fin; and the ventral row originating beneath the intestine and extending out from between the side-muscles to form a support to that portion of the median fin which extends from the branchiopore back to the ventral "blade" of the tail. These blocks are well marked, and form quite a prominent border to the greater part of the outline of the muscular portion of the body. (Figs. 1 and 5, Pl. 1, and Fig. 7, Pl. II.) The series of bodies pertaining to the alimentary canal consist of a mouth ring, a pharyngeal ring and a variable number of rib-like arches placed alternately upon either side of the canal and extending back to about the middle of the body. These different parts are unconnected above, unless it may be to a slight extent with the sheath of the notochord, but below, the two rings, which arise from a common base, are connected with the arches by a cartilaginous trough-like formation which extends back as far as the last arch, and in the sides of which the bases of the arches are firmly imbedded. The *mouth ring* is formed in the integument of the edges of the mouth orifice, and arches forward and upward in conformity to the outline of this portion of the body. It is made up of segments, one for each tentacle, and each segment sends out from the side, at the anterior end, a long, slender prolongation which extends, as a central support, to the very tip of its corresponding tentacle. (Fig. 2, Pl. 1.) These segments, which are the same in number upon both sides of the mouth, do not unite in front, but form arms which end upon either side just at the base of the ram-like extremity of the body, and at these terminations of the "ring" new segments are formed, when, in the growth of the animal, there is room in the oral circlet for additional tentacles.

The odd tentacle which is found in the mouth circlet of Amphioxus, is formed from the center of the basal portion of cartilage from which the two rings originate. The cartilaginous portions of all these tentacles are curved inward, and so directed that the tentacles in the normal condition always cross each other, much as the fingers of a person's hands can be interlaced, and thus form a rude sieve which prevents the entrance of large substances into the digestive tract. The *pharyngeal ring* which marks off the anterior limits of the abdominal cavity, forms a sort of welt or slight constriction around the inside of the anterior portion of the alimentary canal. It is curved backwards upon both sides, and bears upon the posterior border of each curved portion two or three rather large fleshy-looking tentacles. (Fig. 2, Pl. I.) These tentacles generally lie directed backwards against the side walls of the digestive tract, but they can be brought forward so as to extend directly across the canal and form a second barrier to the onward progress of large bodies. In the young this barrier is of much greater service in preventing entrance to the digestive tract than the oral tentacles, as these latter appendages are not sufficiently numerous to act as an efficient guard until the animal is of considerable size, as large or larger than the largest of my young specimens. These tentacles are not always of the same size, and are generally so placed upon the sides that when brought forward they alternate one above the other.

The *branchial arches* are frame-like in structure, long and slender in outline, and run obliquely downwards and backwards across the entire width of the canal—this obliquity is such that the center of the upper portion of one arch is about over the center of the lower part of the next arch in front. The arches are quite numerous, fifty, more or less, upon each side, but I am not aware that there is any definite limit to their number, the largest individual appearing to have the most arches. The greater number of them are of uniform length, but as they approach their posterior limits they gradually become shorter and shorter, to the last one or two, which are less than a quarter the length of the longest ones. The first and second arches are also much shorter than the others, and are about the length of the last ones. The first and last arches are very simple in formation. The first is composed of an oblong framework, pointed at the lower end and nearly square or somewhat pointed at the upper. It is about

twice as long as broad, almost upright in position, and is placed just posterior to the lower curvature of the pharyngeal ring. The last one is merely a round or nearly round ring of cartilage. The rest of the arches are shaped much like the first, but are bi-lobed above and have a central bar which passes from the indentation of the bi-lobed end down to the cartilaginous bed which encloses the pointed lower extremity. This bar is about twice as wide as either side of the arch, and is marked throughout its entire length by a median line which indicates a division into two slender halves. In all of the longer arches there are also three cross-bars, which pass from side to side of the arch at about equal distances between the two ends, and in the shorter arches, except the first and last, which contain none, there are sometimes one, sometimes two of these bars in each arch. These bars pass obliquely backwards and upwards across the arch, and generally go directly from one side to the other, but some of them divide at the central bar and become attached to it, so that they form two short bars instead of one long one. The arches of each side are placed close together, edge to edge, so that they have the appearance of a connected, continuous series of long slender oblique bars, each marked by a median division line and separated by a space of about the same width as the bars themselves, and with cross-bars running, with more or less regularity, across these spaces from alternate bars. The upper edge presents a series of uniform lobes, and the lower edge a series of larger uniform arched points, there being left between each two points a triangular space of considerable size. (Fig. 4, Pl. 1, *a*.) Each complete arch is thus made up of two nearly similar halves, and as the arches of the two sides alternate with each other, as has already been said, the triangular spaces at the bases of the arches not only serve to show the divisions between them, but also indicate the positions of the opposite arches. This alternation can be readily seen by placing an adult animal, when living, under a low power of the microscope, or by a careful dissection of this portion of the body.

The Digestive Tract.—The alimentary canal, which extends along beneath nearly the entire length of the notochord, is somewhat compressed from side to side, varies considerably in breadth in different parts, and is lined throught its entire length with cilia which serve by their action to draw food into the canal for the

nourishment of the animal. The canal may be divided into five rather natural divisions; the mouth cavity, extending from the mouth orifice to the pharyngeal ring; the pharynx, the œsophagus and the stomach, extending from the pharyngeal ring to the division between the abdomen and tail, and which hang from their attachment beneath the notochord freely suspended in the abdominal cavity, being completely enclosed by its walls; and the intestine, which extends along through the tail portion of the animal to the anus, near the posterior extremity. The *mouth cavity*, or first division of the canal, is somewhat triangular in shape, being circumscribed above by the notochord, and below and behind by the two orifices already mentioned. Its anterior upper outline is curved, and it bears upon its walls certain slight, finger-like ridges where the cilia of this cavity are principally aggregated.

At the rather constricted opening of the pharyngeal ring it merges into the *pharynx*, which extends a little past the middle of the abdominal cavity, and is the largest division of the canal. This portion is that in which the branchial arches are formed, and has much the shape of a bean pod, being quite broad along the central part and narrower towards each end, but the posterior extremity tapers much more gradually than the anterior, and where it merges into the œsophagus, it is hardly more than half the size of the portion at the pharyngeal ring. Along its sides, in all the spaces between the bars of the branchial arches, there are long narrow openings, called branchial slits, which place the interior of the pharynx in communication with the abdominal cavity, which is also known as the branchial cavity, or atrium, but which might more properly, perhaps, as will be noted later on, be called the *branchium*. These branchial slits extend, with few exceptions, from the upper curves down through nearly the entire length of the arches, to the edges of the cartilaginous, trough-like bed, being crossed here and there by the cross-bars which serve to stiffen the general framework. In the first two or three arches the clefts do not extend quite to the upper borders. Along the inner edges of these slits the cilia of the pharynx are very long and arranged in rows completely encircling each slit (Fig. 4, Pl. 1), so that by their action they intercept the food particles which are brought into the canal and which might pass through the slits and drive them onward towards the stomach, but allow

the greater portion of the water, in which the food is brought into the canal, to escape into the branchium and be forced, by the contraction of the walls of this cavity, out through the branchiopore once more into the surrounding medium. The *œsophagus* is a short narrow portion of the canal, and leads from the pharynx directly into the *stomach*, which enlarges considerably in diameter, and extends straight back to the end of the branchium. Its walls are rather thicker than those of the other portions of the canal, and upon the inside the cilia are disposed in such a manner that when in motion they force the particles of food, which come into the receptacle, into a long rope-like body, and then cause this food-rope to revolve and twist about until all the nutriment and shape is twisted out of the component particles and the refuse material is forced on into the intestine. The food consists of diatoms, algæ and most any bit of organic material, plant or animal, which is floating in the water in the neighborhood of the animals, and which can succeed in passing the guards and entering the stomach, and if a young animal is taken and placed in some water under the microscope, the entrance of these particles into the canal and their gradual grinding up as they get into this vortex of the stomach, can be readily seen through the nearly transparent tissue, and well repays a little time spent in such observations. Ordinarily these little bits—animals or plants—sail along down the canal without any hindrance from the guards, and as they approach the end of the "rope," they commence rotating slowly about the sides, often, in the case of animals, making uncertain efforts to escape, until after rolling around for a time they are gradually pressed into the mass and twisted on to make room for the others which are continually floating in from the outside. Sometimes a long piece of an alga, or partially decayed bit of organic material, is drawn by the powerful action of the cilia, with a quick rush, against the mouth orifice or into the mouth cavity; then, with a motion which seems nearly instantaneous, the pharyngeal tentacles are brought forward with a sudden flap, the mouth aperture is widely distended, and the offending substance is thrown out of the body together with the water which was in the mouth cavity, after which the tentacles return to their normal position along the sides of the pharynx. This action is often repeated four or five times before the object is gotten rid of, as the action of the cilia tends to

draw the substance back again immediately into the mouth, and at times, after all this labor to get rid of a substance, it finally succeeds in eluding the tentacles, which flag in their activity after a few efforts, and passes on down the canal. From the lower anterior portion of the stomach there is given off a long, slender saccular diverticulum which extends forward along the lower portion of the right side of the pharynx to about the middle of this part of the body, where it is attached by one or two bands to the bars of the branchial arches, and perhaps to the side muscles, Fig. 3, Pl. 1. This organ is considered to represent the liver. It is of a dark-green or brown color, which is probably due to pigment cells in its walls. The walls of the stomach are also colored, but not so deeply as those of this saccular liver. All this portion of the alimentary canal, including the pharynx, œsophagus and stomach, is covered with a delicate membrane which is reflected from the inside of the abdominal walls, and forms along the roof of the branchium, on either side of the canal, a true pleuro-peritoneal cavity, or schizocœle, which extends back quite to the end of the digestive tract. The *intestine* forms the posterior portion of the alimentary canal, and passes in a perfectly direct course from the stomach to the hind end of the body. It is much smaller than any other portion of the canal, and is of uniform diameter except at the posterior extremity where it enlarges to form the funnel-shaped outlet of the anus. It is not known at present time whether the cilia along the course of the alimentary canal are continuously at work drawing in food, or whether they have periods of rest during which they are perfectly quiet. I have never seen them quiet except upon small patches and in weak animals, and then not for any great length of time, but the fact that the stomach and intestine are very frequently found devoid of food, or of all but a small amount of excrement, would seem to indicate that these animals are not always feeding, and this would imply that they can control, in some manner, the action of the cilia. This would accord well with their habits, and would corroborate to a certain extent the statement already made, that they probably have feeding periods, during which they appear at or near the surface, and resting spells, when they hide from sight.

[*To be concluded.*]

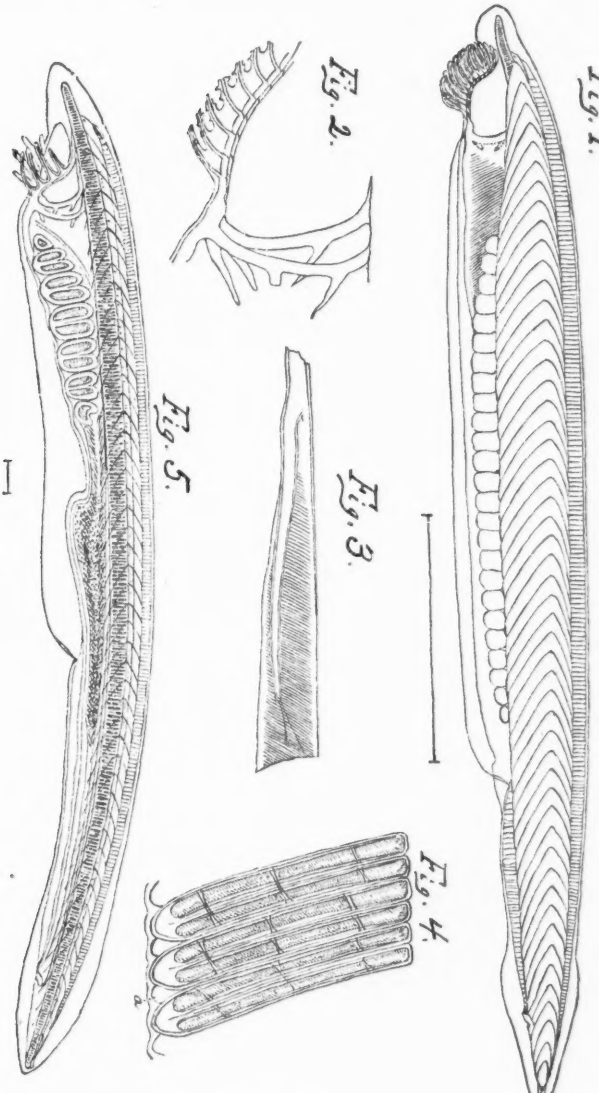
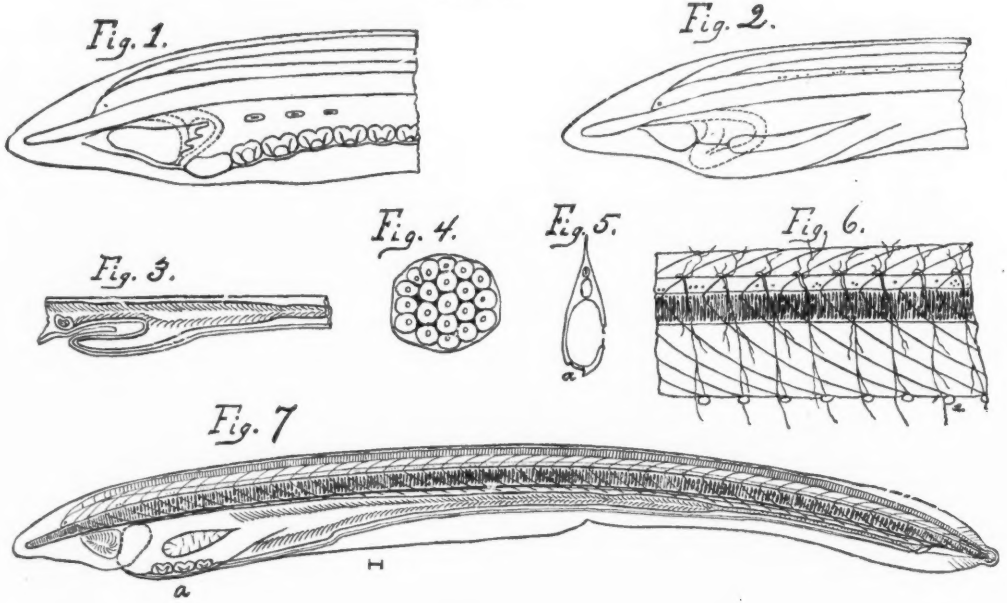


PLATE I.

RICE ON AMPHIOXUS.

PLATE II.



H.J. Rice.

EXPLANATION OF PLATE I.

The full length figures were drawn either from careful measurement of the parts of the animals, or with the assistance of a camera, so that the outlines may be considered as very nearly, if not quite, correct. Under each of these figures is a line representing the length of the individual.

FIG. 1.—Adult female, $1\frac{7}{16}$ths inches in length, seen from the left side. The egg-cases are represented as squarish blocks attached beneath the body-muscles within the limits of the branchium, which is almost fully expanded. The branchial clefts are shown as oblique lines crossing the anterior portion of the pharynx. In this figure the anal opening is represented about $\frac{1}{32}$ of an inch too far back, and, for want of space to make the lines clear and distinct throughout their entire length, the full number of muscle-plates at the ends of the body have not been indicated.

FIG. 2.—The cartilaginous pharyngeal ring with its tentacles and a portion of the branches of the mouth ring. The mouth ring shows the divisions of the branches into segments and the basal portion of the tentacular prolongations.

FIG. 3.—View of the right side of a portion of the pharynx, showing the extent and position of the saccular liver and the slender branches or bands which attach it to the bars of the branchial arches.

FIG. 4.—Three of the branchial arches of the left side, showing the central bars with their central division lines; the extent of the clefts in the length of each arch; the cilia lining the clefts; the triangular spaces, *a*, between the bases of the arches in which are formed the "branchial hearts" of the blood system, and the cross-bars, running from one side of the arches to the other, and acting as stiffeners to the cartilaginous framework.

FIG. 5.—Young animal, $\frac{3}{32}$ds of an inch in length. The mouth aperture is an eccentric opening upon the left side and partially surrounded by the forming tentacles. The branchial arches are large and prominent, and seven in number, and the liver cæcum is just forming from the central portion of the alimentary canal.

EXPLANATION OF PLATE II.

FIG. 1.—Left side of the anterior portion of the body of a young Amphioxus, showing the first six pharyngeal openings, the first three openings for the left branchial arches, and the mouth-cavity as it appears shortly after the cleft from the pharyngeal mouth aperture to the ciliated pit has closed. The peculiar shape of the anterior pharyngeal openings is caused by their position upon the right side of the median line of the pharynx.

FIG. 2.—An earlier stage of the same portion of the body shown in FIG. 1. Here the pharyngeal mouth aperture, the ciliated mouth cavity, and the cleft connecting the two are plainly indicated.

FIG. 3.—Portion of the alimentary canal of a young animal including the last branchial opening upon the left side of the pharynx, and the entire stomach cavity, and showing the forming liver diverticulum with the ventral blood vessel conforming to its lower border.

FIG. 4.—An egg capsule with its quota of ova, very much enlarged.

FIG. 5.—Diagrammatic cross-section of the body of a young Amphioxus. Section made through the pharyngeal mouth aperture and one of the pharyngeal clefts, as at *a*, Fig. 7, to show the connection of these openings with the central canal. The point upon the body wall or mouth welt, just to the right of the letter *a* in the figure, ought to be more sharply defined to represent one of the tooth-like processes of the mouth welt.

FIG. 6.—View of a portion of the muscular system of the left side of the body of an adult, showing the disk-like character of the notochord; the muscle-plates of the side muscles; the distribution of the nerves of the side, and the attachment and form of the generative bodies, *a*, at ordinary seasons.

FIG. 7.—Young animal, $\frac{5}{64}$ths of an inch in length, showing pharyngeal mouth opening with teeth; cartilaginous pear-shaped welt; ciliated pit, and the first three pharyngeal openings.

SKETCH OF NORTH AMERICAN ORNITHOLOGY IN 1879.

BY DR. ELLIOTT COUES, U.S.A.

SINCE the year 1858, memorable in our annals for the appearance of Baird's great work, which gave such an impetus to the study of birds in this country, and in the light of which a generation of ornithologists has grown up, activity in this department has been incessant; and the workers in this field have never been more numerous or more in earnest than during the year just passed—one which, though marked in no especial manner, has witnessed a steady advance in the extent and in the precision of our ornithological knowledge.

Foremost among the signs of the times stands the *Bulletin of the Nuttall Ornithological Club*, the fourth volume of which closed with 1879. Originating in the necessity which the Club experienced to have a medium of communication with the public, and edited by Mr. Allen with conspicuous ability, this periodical soon secured firm foothold, and its success became assured. The magazine, devoted entirely to the technic of a branch of science, is phenomenal in the fact, that so special a publication has paid for itself from the start, and already doubled its size. It is a trite saying, though generally an untrue one, that such and such a publication "fills a real want," but this is actually the case here. Nearly all the working ornithologists of America record the progress of their affairs in the "Nuttall," so that if one wishes to know what has been found out since the appearance of the last formal treatise on our birds, he turns to the *Bulletin* with confidence. In fine, it answers in America to the English *Ibis* and the German *Journal für Ornithologie*. It is, of course, impracticable to give here any analysis of its contents, and to mention a few leading papers would be both invidious and unnecessary.

It may not be so generally known that there is published at Utica, N. Y., by S. L. Willard, a bi-monthly periodical entitled *The Oölogist*, devoted entirely to the nests, eggs and breeding habits of our birds. Beginning very modestly, *The Oölogist* has more than held its own; several volumes are completed, the size has been enlarged, and the conduct of the periodical has become so workmanlike that the claims of this serial to general recognition are just.

In the same connection we should not fail to notice the

increasing attention paid to ornithology by several of the semi-scientific papers, notably Charles Hallock's *Forest and Stream*, of New York, and Dr. Rowe's *The Field*, of Chicago. Though of course dealing chiefly in game birds, the natural history department of these papers gives us a good deal of ornithological matter; the articles are grown more shapely, with a smaller proportion of untitled, anonymous or otherwise "scrappy" pieces; on the whole, these contributions rank with those of the London *Field*, and many of them are precisely of the character of the shorter notes in the *Nuttall Bulletin*, or in Harting's *Zoölogist*. In the case of *Forest and Stream*, we believe the commendable state of affairs to be largely due to the zeal and competence of Mr. George B. Grinnell, whose example in this particular is to be emulated.

Science News, a fortnightly record of progress in science, established and edited in New York by W. C. Wykoff and Ernest Ingersoll, contains a fair proportion of ornithological matter. Among articles of 1879 may be noted Ingersoll's instructions for forming collections of nests and eggs, and a part of G. B. Sennett's experiences on the Rio Grande. We regret to learn that the publication died with the year.

The promptly-appearing and readily-available avenues of communication thus far mentioned have naturally absorbed most of the current items of ornithological information or entertainment for the year, less than formerly falling to the share of the AMERICAN NATURALIST, and the slower or more irregular publications of scientific societies containing but few papers, all of a very technical character.

Leading these last comes the *Proceedings of the U. S. National Museum*, published by the Department of the Interior under the direction of the Smithsonian Institution. The completed first volume dates 1879, about half of it appearing in sheets in 1878. Here are found the complete results of Mr. F. A. Ober's Explorations in the Lesser Antilles, elaborated in a series of important papers by Mr. G. N. Lawrence. One paper on these collections was in *Forest and Stream*, and descriptions of several of Ober's new species are given in the *Annals of the New York Academy of Science*, but the whole matter is finally set forth in the publication in mention. The *Proceedings* also contain several important papers by R. Ridgway, on neotropical birds, describing new species, monographing the genus *Tyrannus*, &c.,

together with L. Belding's extended list of Californian birds, edited by Mr. Ridgway. Vol. II opens with a paper by Dr. T. M. Brewer on *Empidonax*.

The *Bulletin of the U. S. Geological Survey* gives us its fifth and, as we particularly regret to add, its final volume this year. It consists of the usual four numbers, of which the first and second and third have appeared, the fourth being still in press, delayed by printing E. Coues's protracted and tedious bibliographical matter. In this volume are several papers on birds. Dr. C. E. McChesney, U. S. A., has some valuable notes on the Birds of Fort Sisseton, Dakota. Mr. George B. Sennett gives an extensive and important paper on the results of his second season's operations in Texas, adding several new species to our fauna, with great store of information respecting the habits of the birds of the Rio Grande. Dr. Morris Gibbs gives an annotated list of the birds of Michigan. Dr. Coues prints an article on the present status of *Passer domesticus* in America, including an historical résumé of the quarrel over the sparrow, which has set the brethren of Boston and Washington so by the ears. The same writer also offers a second instalment of his ornithological bibliography, similar in scope and plan to that which forms the appendix to his "Birds of the Colorado Valley," but relating to neotropical instead of nearctic birds.

In the *Proceedings of the Boston Society of Natural History*, Dr. T. M. Brewer gives additional notes on the birds of New England, and Mr. E. A. Mearns has published in the *Bulletin of the Essex Institute*, several instalments of an elaborate and valuable list of the birds of the Hudson Highlands, N. Y.

The *Transactions of the Illinois Horticultural Society*, for 1878, published in 1879, contain a paper on economic ornithology, by Prof. Forbes; and we may add that previous volumes of the same publication contain similar matter, perhaps none too well known. It is an important practical subject; such contributions to which as those of Prof. Forbes, of Prof. Aughey (in the First Annual Report of the U. S. Entomological Commission, 1878), of Dr. J. M. Wheaton (Twenty-ninth Report Ohio Board of Agriculture, 1875), merit special attention pending the sparrow question.

The *Journal of Science*, edited at Toledo, Ohio, by Dr. E. H. Fitch, continues to give popular articles on birds, mostly by the editor, and usually illustrated.

The *Familiar Science and Fanciers' Journal* continues to fill its

chosen sphere well, and has frequent articles of more technical character. Dr. Wm. Wood has here continued his "Birds of Connecticut."

The most important — we had almost said the only very important—contribution to systematic ornithology, among special treatises, is Elliot's Synopsis of the *Trochilidæ*, published as one of the Smithsonian *Contributions to Knowledge*. It is a really great work, which bids fair to supersede Gould's Monograph in all that relates to the technic of the subject. As witnessed by the many critical papers which Mr. Elliot has published during the progress of his study of this family of birds, the author has been unwearied in his attention to the subject, and this extensive quarto gives his final results. Mr. Elliot is "conservative" to a degree; very many nominal species are reduced to synonyms, the preparation of the lists of which shows great care and judgment; and the ridiculously over-large number of genera which various writers have sought to establish, have found what we trust will be their final resting place. Numerous illustrations, from Mr. Ridgway's pencil, fitly illustrate the text of a memoir which instantly becomes indispensable to the working Trochilidists and which will undoubtedly carry the weight of the leading authority on the subject.

Since Audubon's pencil and brush fell from the hand which for so many years turned them to works of unsurpassed beauty, nothing in the way of ornithological art appeared in this country to challenge comparison with the work of the great master until, from an unexpected quarter, the "Illustrations of the Nests and Eggs of the Birds of Ohio" were laid before us by the Misses Jones and Shulze, of Circleville, Ohio. Two numbers of this splendid work have appeared during the past year, and the prospect of the completion of the undertaking brightens as the merits of the "Illustrations" become better known, notwithstanding the untimely death of the leading author on the threshold of her enterprise. This work is in folio, and is published by subscription, in parts, each to contain several colored plates of nests and eggs, of life size, with sheets of descriptive letter press. Combining as it does, the merits of fidelity to nature with artistic excellence, this work commends itself in an especial manner to all those who have a taste for the beauties of bird-life, as well as those who make ornithology a severe study.

Another contribution to our knowledge of the eggs, nests and

breeding-habits of birds is essayed by Mr. Ernest Ingersoll, and so far accomplished in a most meritorious manner. Three numbers have appeared during the year past, in March, August and October respectively. This work is in large octavo, with several colored plates of eggs to each number, and more or less extended biographies of the species. Excepting in certain particulars, which we have noted in other places already, the mechanical execution does great credit to the publisher, Mr. Cassino; and the completion of this extensive work in the manner in which Mr. Ingersoll has begun it cannot fail to enrich the literature of the subject.

We are glad to see the steady progress made by Mr. C. J. Maynard in his meritorious and laborious undertaking, which, beginning as the "Birds of Florida," has been remodeled and enlarged in scope, to represent a history of the birds of Eastern North America. Mr. Maynard is a practical ornithologist of large field experience; his biographies have the unusual merit of originality and make interesting reading, while the attention he pays to the anatomical structure of birds gives prominence to one aspect of the subject much neglected in this country. The work is in quarto, with colored plates; it is published in parts, about a dozen of which have appeared, and deserves to succeed.

With due deference to Herbert, whom, as "Frank Forester," the disciples of St. Hubert seem to have canonized as only a lesser than their patron saint himself, we may refer to Dr. Lewis's work on American Field Sports as one of the most agreeable and reliable of books of this kind, and one a new edition of which has appeared this year.

The veteran taxidermist, collector and dealer of Philadelphia, Mr. John Krider, has also contributed to such literature in the publication of his experiences of "Forty Years."

"Wilsoniana" bids fair to become scarcely less extensive and fertile a field than "Waltoniana" has long been. The appearance not long since of A. B. Grosart's two portly volumes on Wilson's life, character and writings, both prose and poetry, and rather miscellaneous than ornithological, freshened the theme. It may not be generally known that the "father of American ornithology" was anything (and almost everything) but an ornithologist, until the decade before his untimely death in his prime, when his genius at last found its "place in nature," and achieved immortality. Every scrap of paper relating to the "melancholy poet-naturalist" has been eagerly sought for by his

successive biographers, and Grosart, his latest and most enthusiastic admirer, seemed to have told us all we were likely to learn of the man. It was, therefore, with peculiar pleasure that the present writer acquired, from Miss Malvina Lawson, daughter of Wilson's famous engraver, an autograph letter of Wilson's, which was found, on comparison with the documents in Ord's "Life," and in Grosart, to have never been published correctly, or in full. It is that one which, dated Pittsburgh, February 22, 1810, gives an account of Wilson's boat voyage down the Ohio. It is printed verbatim, along with certain letters of George Ord's and Prince Bonaparte's, in the *Penn Monthly* for June, 1879. The writer also received, from the same source, an excellent drawing, never published, of the schoolhouse, near Gray's Ferry, where Wilson taught; and which he would make over to any enterprising publisher who would have it properly engraved.

This slight sketch need not be left without allusion to the "sparrow literature" of the year—a curious mass of raw and not over-nice material, which will, nevertheless, be not without its "final cause," if it contributes to the very desirable settlement of the vexed question of the European sparrow in America.

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HISTORICAL SKETCH OF THE SCIENCE OF BOTANY IN NORTH AMERICA FROM 1840 TO 1858.

BY FREDERICK BRENDEL.

[*Continued from p.* 771, *Vol. XIII, American Naturalist.*]

AT the time when Torrey and Gray commenced their first work on the Flora of our continent north of Mexico, Sir William Jackson Hooker, the celebrated English botanist, had finished his great work on the Flora of British America, two volumes, in quarto, with 238 plates, London, 1833-1840. But, before we proceed farther, we have to review the early history of botany in the most northern and Arctic regions of North America.

Hans Egede, a Danish missionary, was, from 1721 to 1736, in Greenland. After his return to Denmark, he published, in 1741 a description of that country. He describes, vaguely, some plants, with some drawings on one plate, but it is rather difficult to make out what the drawings mean. Afterwards his son, P. Egede, made some botanical collections, which, as well as those of Gieseke, who published a Flora Grœnlandica, 1816, in Brewster's Edinburg Encyclopædia, and those of Wormskiold, are preserved in the herbaria of Hornemann and M. Vahl.

Some Greenland plants were described, 1770, by Rottboell, professor in Copenhagen, and, in the same year a history of Greenland was published by the missionary Cranz; the plants in it were described by Schreber.

The largest collections were made in this century by Jens Vahl, the librarian of the botanical garden in Copenhagen, who traveled nine years in Greenland, and probably there will not many new discoveries be made. J. Lange's catalogue of Greenland plants (in Rink's work on Greenland, 1857), contains 320 species in 52 orders.

A list of plants collected on the coast of Baffin's bay was published by Robert Brown, in 1819, and by the same a "Chloris Melvilleana," 1823, containing 131 species, of which 80 are phenogamous, collected at different times by Sabine, Edwards, Ross, Parry, Fisher and Beverley.

Scoresby's collection in East Greenland, was described by Hooker in 1823, and that of Sabine in 1824.

John Richardson, born in Scotland, 1787 (died 1865), was the naturalist of the expedition from the shores of Hudson's bay to the Polar sea, 1823, under the command of Franklin. This expedition started from York Factory, on Hudson's bay, and proceeded via Cumberland House, Carlton House, Fort Chippeway, on the Athabaska lake, Fort Providence, on the Slave lake, and Fort Enterprise, 65° N. latitude, to the Coppermine river, then along the coast eastward to Cape Turnagain, the Hood river up to Fort Enterprise, to Norway House, on the Winnipeg lake, and back to York Factory. The collection of plants contained 700 species, and was published by Richardson in the botanical appendix to Franklin's Narrative, printed 1823.

The narrative of the discoveries on the north coast of America, by Simpson and Dease, in 1837, published in 1843, contains a catalogue of plants examined by Sir William Hooker, but nothing new; all the species were already collected by Richardson.

Berthold Seemann (born in Hanover, 1825), the naturalist on board of H. M. S. *Herald*, under the command of Captain H. Kellet, during the years 1845-1851, described, in a letter addressed to Sir William Hooker (in Journal of Botany), the arctic Flora of Kotzebue Sound, and published, 1852-1857, the botany of the expedition, the first part of which contains the Flora of Western Esquimaux land.

Bachelot de la Pylaie, a French botanist, explored, in 1819 and

1820, Newfoundland and the little islands of Miquelon and St. Pierre. He published, 1829, Flore de l'isle de Terre Neuve, which was not finished, and contains only a description of cryptogamous plants.

A Flora of Labrador was compiled by E. Meyer, professor of botany in Kœnigsberg, in 1830, from a small collection by the missionary Herzberg, and a number of species made known by Schrank, professor of botany in Munich. These plants were collected by a Danish missionary, Kohlmeister, probably the same that Pursh calls Colmaster in his Flora, and the plants of which he found in the herbaria of Dickson and Banks. The number of all the species of Labrador known at that time, was 198, of which 30 are cryptogamous.

The north-west coast was visited, 1838, by the expedition of H. M. S. *Sulphur*, under the command of Sir Edward Belcher. This expedition explored the Pacific during the years 1836-1842. The botanist was Mr. Barclay, in the service of the Kew garden, assisted by the surgeon Hinds and Dr. Sinclair. The parts visited were Prince William's sound, Port Mulgrave, both under 60° N. L., Sitka, Nutka sound, San Francisco, Sacramento river and Monterey in California. The botanical collections were described by George Bentham, in "Botany of the voyage of H. M. S. *Sulphur*," 1844, with 60 plates.

The U. S. Naval exploring expedition, under the command of Charles Wilkes, which crossed the Pacific during the years 1838 to 1842, in every direction, arrived, 1841, in Oregon. Charles Pickering was collector on this expedition. The Columbia river up to Walla Walla, and the Willamette valley were examined: afterwards the Sacramento river down to San Francisco. In Oregon were collected 1218 species, and 519 in Northern California; the whole collection of this expedition amounting to 9600 species, were examined. The phanerogamous plants were described by Dr. Torrey; the ferns of the expedition, by Dr. Brackenridge; the mosses by Mr. Sullivant; and the lower cryptogams by other botanists.

N. J. Andersson, a Swedish botanist, naturalist of the voyage around the world of the Swedish frigate *Eugenie*, collected in 1852, in California; he took particular notice of the willows, and in 1858, he published in Proceedings of American Academy of Arts and Sciences, a "Synopsis of North American Willows," of which he

enumerates fifty-nine species, a number of which he degraded to the rank of sub-species in his Monographia Salicum, 1863. He is the author of the genus Salix in Decandolle's Prodromus.

Besides the Rocky mountains and California, another large field opened for exact exploration. The Mexican war and the acquisition of new territories caused a long series of expeditions to California and those tracts of land which form with West Texas the North Mexican botanical province.

In June, 1842, Lieut. Fremont set out from the mouth of the Kansas river, followed that river about one hundred miles, passed over to the Platte river, traveled up the river to the junction of the north and south fork, where the party divided, one part following the north fork to Fort Laramie, the other proceeding along the south fork to Fort St. Vrain, and from there to Fort Laramie. Then the expedition followed the north fork and the Sweetwater river up to South Pass, and the Wind River mountains, the highest peak of which, afterwards called Fremont's Peak, he ascended. Returning, the Platte river was followed to its mouth. The collection of plants, consisting of 352 species, contained fifteen new ones, described by Torrey.

The collections of Fremont's second expedition, during the years 1843 and 1844, which extended to Oregon and California, were greatly damaged, so that in many instances it was extremely difficult to determine the plants. Torrey furnished the description of a few new genera and species, which, with four plates, was published in App. C. to Fremont's Report. One of these new genera he named Fremontia, but this name was afterwards withdrawn, as Nees had already described the plant under the name Sarcobatus, and Fremont's name was transferred to another new Californian genus of the order of Sterculiaceæ.

Two other expeditions were undertaken by Fremont in 1845-1846 and 1848, extending to California. Large collections were made again, but the greater part of them were destroyed by the same mishaps. Some of the new genera that were saved for examination were described and published in 1850, by Professor Torrey in the Smithsonion Contributions, as "Plantæ Fremontianæ," with ten beautiful plates.

Emory's military expedition traversed in June and July, 1846, the plains from Fort Leavenworth to the bend of the Arkansas, followed this river to the Pawnee fork, crossed the Raton moun-

tains (7000 feet) and the ridge between the Canadian river and Rio Grande to Santa Fé; then again the dividing ridge (6000 feet) between the Rio Grande and Gila, followed the latter to the Colorado of the West, and arrived at St. Diego. The botanical collections (about 200 species) were examined by Torrey, the Cactaceæ by Dr. Engelmann, and published in Appendix 2 of Emory's Report. A small number of plants was collected by Lieut. Abert, amongst which was nothing new.

Dr. A. Wislizenus, born in Germany, 1810, left St. Louis in the spring of 1846, with the intention of traveling in North Mexico and Upper California. He undertook the journey at his own expense, and war was not yet declared, when he arrived at Chihuahua; but there he was arrested as a spy, and transported to Cosihuirachi, at which place he was left in a "passive" condition; that means as to his free will to leave; for, as a collector, he was very active on this rich field, where he collected so many species not found before. Six months afterwards, Colonel Doniphan's troops occupied that part of the country, and Wislizenus accepted a situation in the medical department of the American army, and, instead of going westward as he first intended, he followed the army to Monterey, and returned via Matamoras to the States. He collected a large number of plants. In an Appendix to the "Memoir of a tour to North Mexico in 1846 and 1847, by A. Wislizenus, M. D., printed for the use of the Senate of U. S.," the botany of the explored country is described by Dr. Engelmann. Amongst the new species were over thirty new species of Cactus.

West Texas was extensively explored since 1835, when Ferdinand Lindheimer (born in Germany, 1802), settled at New Braunfels, where he lives yet. His large collections were named and described by Gray and Engelmann, in Boston Journal of Natural History, as Plantæ Lindheimerianæ, part I in 1845, part II in 1847. Many of these plants were shortly afterwards described by Scheele, in Linnæa, from a collection brought to Germany by the geologist F. Roemer, who studied the geology of Texas in 1846-1847, and received many specimens from Lindheimer.

Completed and extended to the whole area of the Rio Grande, were these explorations by Gregg and Wright.

Josiah Gregg, the author of the "Commerce of the Prairies, 1844," made large botanical collections, but died soon (1849) in California.

Charles Wright spent several years in Texas, the botany of which country he studied. Then, in 1849, he went westward to El Paso, in New Mexico. His rich collections of plants were placed in the hands of Prof. Gray, who described and published "Plantæ Wrightianæ" in the third volume of Smithsonian Contributions, with ten plates. In 1851–1852, he was again in New Mexico, the collection of which tour furnished the material to the second part of Plantæ Wrightianæ, with four plates, in the fifth volume of the Smithsonian Contributions.

Another well-known botanist explored New Mexico at the same time. August Fendler came, about the year 1836, from Germany to North America. In 1846 he left Fort Leavenworth with a military train, followed the Arkansas river up to Fort Bent, crossed the mountains to Santa Fé, where he made his principal collections from April to August, 1847. An account of his collection Prof. Gray published in the Memoirs of the American Academy, Vol. IV, under the title, Plantæ Fendlerianæ. Fendler resided a long time near St. Louis; went afterwards to Venezuela, and is now collecting on the Island of Trinidad.

Dr. Woodhouse was a member of the expedition down the Zuñi and Colorado rivers under the command of Capt. Sitgreaves, in 1850. His collections, placed for examination in the hands of Prof. Torrey, consist of three portions: the first, collected between Neosho and Arkansas rivers, and on the north fork of the Canadian, and the second, from Texas, contain nothing new. The plants of the third portion were collected in Arizona and California. The catalogue of the latter (about 180 species) is published with twenty-one plates, in 1853, with Sitgreaves' Report. There is described a new genus of the order of Amarantaceæ and several new species.

In the year 1852 an expedition under the command of Capt. Marcy explored the Red river to its sources. The botanical collection of 200 species, made by Dr. Shumard, was examined by Prof. Torrey. and published in App. G of Marcy's Report with twenty plates.

The botany of these formerly Mexican provinces was nearly unknown before Berlandier; but by the collections of the above-named botanists much light was thrown upon it; their work was further advanced by the Pacific railroad explorations and the Mexican boundary survey, and will be completed by the surveys of the

Territories in progress yet. Here may be mentioned, though not in the compass of this historical sketch, the surveys of Hayden, Powell, Wheeler, and King, who surveyed the State of Nevada, and whose report contains, in the fifth volume, the botany of Nevada and Utah, by Sereno Watson.

Several expeditions were ordered by the Government, in 1853, to cross the Rocky mountains to the Pacific, along certain parallels, to explore the most practical route for a railroad to the Pacific coast. The parties consisted of a military command and a number of technic and scientific assistants. The reports of these explorers were afterwards published by the Government in thirteen quarto volumes, extensively illustrated and full of the most important scientific matter. The botanical collectors were the following: Dr. Suckley, naturalist to the party of Gov. Stevens, who proceeded between the parallels 47 and 49 to Oregon. The botanical report of this route, with six plates, we find in the last volume; it contains the collections of Suckley on the plains, 323 species, examined by Prof. Gray (one genus and three species were new), and a catalogue of plants from Washington territory collected by Dr. Cooper. Those east of the Cascade range, 75 species, of which two were new, were examined by Prof. Gray, those of the west side, 386 species, of which one was new, collected by Suckley and Gibbs, were examined by Torrey and Gray. A general report on the botany of the route is written by Dr. Cooper.

In Vol. II, Torrey and Gray reported on the collection of plants made by F. Creutzfeldt, a German gardener from St. Louis, who was engaged as botanist under the command of Capt. Gunnison, and was killed with the same, by the Indians, near Sevier lake, Utah. He collected 124 species, with two new ones; the report is illustrated by three plates. After the murder of Gunnison, the party reached, under Lieut. Beckwith, the Great Salt lake, where the winter was passed. J. A. Snyder, the topographer of the party, took charge of the botanical collections made along the 41st parallel, from the Great Salt lake to the Sacramento river. The plants, 59 species, were published by Torrey and Gray. There were seven new species, illustrated on seven plates.

The richest collection was that of Dr. J. M. Bigelow, under Capt. Whipple, along the 35th parallel; it is published in Vol. IV, and contains 1109 species of vascular plants, amongst which nine

genera and seventy-two species were new, illustrated by twenty-five plates. In a separate report Dr. Engelmann described fifty Cactaceæ, of which eighteen were new and illustrated by twenty-four plates, and Sullivant seventy-two mosses, with twelve new ones and ten plates. Very instructive is the general description of the soil, of the productions along the route, and the forest trees by Bigelow.

The route near the 32d parallel, from El Paso to Preston on the Red river, was explored by Capt. Pope. Dr. Diffendorfer made the botanical collections, which contained 268 species, of which three genera and thirteen species were new. The catalogue is published by Torrey and Gray in Vol. II of the Reports, with ten plates.

Dr. A. L. Heermann was the naturalist under the command of Lieut. Williamson, who explored the passes in the Sierra Nevada and the coast range. The catalogue of eighty-eight species, amongst which were fourteen new ones, with eighteen plates, described by Durand and Hilgard, we find in Vol. V, with a separate collection of the geologist, W. P. Blake, containing eighty-seven species, with six new ones and ten plates, described by Dr. Torrey.

Vol. VI contains the interesting botanical report of Dr. J. S. Newberry, geologist under the command of Lieut. Williamson when he explored the country between the Columbia river and Sacramento river. Besides an article on geographical botany, he described the forest trees with ten plates, and added a catalogue of 531 vascular plants (two genera and eight species were new) with six plates, twenty mosses and ten lichens. He was afterwards a member of the expedition on the Colorado of the West, under the command of Lieut. Ives, in 1857–1858. The report was published in 1861, and part 4 contains the catalogue of plants examined by Gray, Torrey, Engelmann and Thurber, 400 species with ten new ones.

Dr. Thomas Antisell collected, under the command of Lieut. J. G. Parke, between the Rio Grande and Southern California, 281 species (one genus and three species were new), which are published with eight plates in Vol. VII of the reports.

The Mexican boundary survey began in 1849, and continued with an interruption, and after a reorganization under Major Emory in 1853, till 1856. The report of Emory was published,

1858, in two large volumes; the first half of the second volume contains the botany. An introductory chapter on geographical distribution and botanical features of the country was written by Dr. C. C. Parry, the catalogue of plants, with descriptions of twelve new genera and 195 new species, with illustrations on sixty-one plates, by Torrey, partly by Gray and Engelmann, who elaborated the Cactaceæ separately and described ninety-two species, of which not less than forty were new, with seventy-five plates. The whole work contains under 2140 species, 235 new ones. The most new species, besides the Cactaceæ, we find amongst the Euphorbiaceæ (36), described by Engelmann, then under the Compositæ (32), and the Scrophulariaceæ (19), both orders described by Prof. Gray. Eight orders comprise half the species of the collection: Compositæ 430, Leguminosæ 212, Euphorbiaceæ 101, Cactaceæ 92, Scrophulariaceæ 71, Cyperaceæ 61, Labiatæ 53 and Cruciferæ 47. The large order of Gramineæ, elaborated by Dr. George Thurber, was unfortunately omitted on account of the already too great size of the volume. Geo. Thurber was one of the botanists of the survey under Bartlett at the same time with Dr. J. M. Bigelow. Gray published already, in 1854, in Memoirs of the American Academy of Arts and Sciences, N. S. Vol. v, "Plantæ novæ Thurberianæ," twenty-eight species, of which six belong to six new genera. Charles Wright was attached by Col. Graham to his separate corps of the survey. Under Emory, Dr. C. C. Parry and A. Schott made the botanical collections.

The important result of all these explorations was not only the multitude of new genera and species made known, but the light thrown upon the distribution of North American plants. It was recognized that there is an unmistakable difference between the eastern wooded, the central treeless and the Californian sections of temperate North America, of which the first may be called the sylvan, the second, the campestrian, and the third, the Californian botanical province. The campestrian province reaches from West Texas to Southern California, and far north on both sides of the Rocky mountains; the Sierra Nevada and Cascade range, in Oregon, form the western border, but on the east side there is no sharp line, the prairies stretching into the wooded country. That the flora of East Texas is identical with that of Louisiana and the other Gulf States, Engelmann has suffi-

ciently demonstrated in the Proceedings of the American Association, fifth meeting, 1851.

At the time of Fremont's first expedition, two German botanists directed their lonely ways to the Rocky mountains and to the Territory of Oregon.

Carl Geyer, born 1809, came to America in 1835. As already mentioned he was employed as a collector by Nicollet, afterwards he crossed the Rocky mountains under 40° N. L. to Oregon territory. His rich collections were sent to Sir William Hooker, who examined the plants and described fourteen new species in *Journal of Botany*, 1845 to 1856. Geyer himself furnished interesting remarks on the features of the country. He returned in 1845 to Germany, and died there in 1853.

Lueders, from Hamburg, crossed the Rocky mountains in 1843, and made collections in Oregon Territory. Fremont met him near the Cascades of the Columbia river, where he (Lueders) lost his package by capsizing of his canoe in the rapids, an accident which Fremont memorized by naming a little bay in that locality after his name Lueders' bay, probably a poor reparation for his loss. Nothing was known of him afterward.

Descriptions of plants collected by Dr. Wm. Gambel in the Rocky mountains and California were published by Thomas Nuttall in the Proceedings of the Academy of Natural Sciences of Philadelphia, in 1848. He proposed twelve new genera and 106 new species, but not all of these remained valid.

Captain Stansbury explored, 1849–1850, the valley of the Great Salt lake. His report was published by the Government in 1852. Appendix D contains the botany examined by Torrey, 114 species, of which three were new and some new varieties, with nine plates.

The knowledge of the botany of British America was greatly promoted by Sir John Richardson's Arctic searching expedition, published in two volumes, London, 1851. The object of the expedition was the search for the lost Captain Franklin along the north coast. The voyage was made in boats from Lake Superior via Lake Winnipeg to the Mackenzie river, then from Great Bear lake to the Coppermine river, and lasted from May, 1848, to Sept. 1849. In the Appendix (more than half the second volume) we find chapters on the physical geography, climatology and geographical distribution of plants north of the 49th parallel, with

most valuable observations. There is a list of trees and shrubs with their northern limits, and a table of the distribution of Carices, which was prepared by Dr. Francis Boott, one of the best authorities and author of the beautiful "Illustrations of the genus Carex," the 4th part of which was after his death published by J. D. Hooker. Boott was born in Boston, 1792, and died in London, 1863.

In the summer of 1848, Prof. Agassiz made a scientific excursion to the Lake Superior with a number of students. He published, 1850, a volume on the physical character, vegetation and animals. Two chapters treat of the botany on the shore of Lake Superior compared with that of the Jura and the Alps. The accounts of such excursions are highly interesting, when related by competent botanists, *e. g.*, that published by Prof. Gray in 1841, in *Silliman's Journal*, "Notes of a Botanical Excursion to the Mountains of North Carolina."

The most prominent American botanists of our times are Torrey, Gray and Engelmann.

John Torrey was born in New York, 1798, and died on the 10th of March, 1873. Author of many botanical writings, he published, as early as 1819, a "Catalogue of plants growing spontaneously within thirty miles of the city of New York;" in 1824 a "Flora of the northern and middle sections of U. S.," of which only Vol. I was printed, containing Classes I-XII of the Linnæan system, which was at that time yet in general use; 1826, a "Compendium of the Flora of the Northern and Middle States;" 1836, a "Monograph of the North American Cyperaceæ" (in Annals of the Lyceum of New York, Vol. III); from 1838 to 1843, with Asa Gray, the first two volumes of the Flora of North America already mentioned. It contains the orders from Ranunculaceæ to Compositæ, and was not continued at that time, but will be finished now, since the large amount of new material brought from the Western explorations is nearly worked up. In 1843 appeared his "Flora of the State of New York," two large quarto volumes, with 162 tables, forming the second part of the Natural History of New York. In the preface we find a historical sketch of the botanists and their work in the State before that time. His other writings are already mentioned.

Asa Gray was born on the 18th of November, 1810, in Paris, Oneida county, New York, and is now Professor of Botany of

Harvard University, at Cambridge, Mass. His first work was published 1834-1835, "North American Gramineæ and Cyperaceæ," two volumes, containing each one hundred species, illustrated by dried specimens. It was followed by "Elements of Botany," 1836; "Melanthacearum Americæ septentrionalis revisio," 1837; the "Botanical Textbook," 1842 (third edition, 1850); "Chloris Americana," illustrations of new, rare and otherwise interesting North American plants. Decade 1, with ten beautiful plates, 1846 (not continued). The first edition of his well-known "Manual of the Botany of the Northern States," appeared in 1848, and was followed by many editions. "Genera Floræ Americæ boreali-orientalis illustrata, Vol. I and II, with 186 tables," from Ranunculaceæ to Terebinthaceæ, was not continued. Already mentioned are many of his contributions in public documents, Smithsonian publications and scientific periodicals, too numerous to be all named, but all of the greatest value.

George Engelmann, born in 1810, in Frankfurt-on-the-Main, came to America about the year 1834, and has resided since that time in St. Louis, Missouri. Except his writings mentioned above, he has published, in different periodicals, a number of monographs of difficult orders and genera, *e. g.*, Cactaceæ, 1856, Cuscutæ, 1859. His papers on North American Juncus, Quercus, Yucca, some Coniferæ and Gentianæ are later.

Other active botanists of that period are A. Wood, who published a "Classbook of Botany," which is much in use. There is a "Botany of the Northern States," by L. C. Beck, professor in Albany, who lived from 1798 to 1853; a "North American Botany," by Eaton and Wright; an "Introduction to Botany," by Comstock; an "American Flora," by Strong; a "Botany of the Southern States," by Darby.

Local floras and catalogues of plants were compiled, by Dewey: Report on the Herbaceous Plants of Massachusetts, 1840; by Emerson: Report on the Trees and Shrubs of Massachusetts, with seventeen plates, 1846; by Lapham: Plants of Wisconsin, 1849, and a Catalogue of Plants of Illinois, published in the second volume of Trans. of Ill. State Agric. Soc., 1857. Catalogues and notes on the botany of this State were published previously, 1826, by Dr. L. C. Beck, and, 1843, by C. Geyer, with notes by Dr. Engelmann, both in *Silliman's Journal*, then 1845, by Dr. C. W. Short in the *Western Journal of Medicine*. Much has been done

for the knowledge of the botany of Illinois by Dr. S. B. Mead, of Augusta, Hancock county, and Dr. G. Vasey, of McHenry county.

Amongst the American botanists, although born in Germany, may be named Dr. Rugel. He came, in 1842, to America, and settled afterwards in East Tennessee, where he lately died. He collected in the South-eastern States, and used to send his collections to Shuttleworth, in Geneva (Switzerland).

There is a number of catalogues which fall partly in the latter time of the second period, that of Bachman, of the plants in the vicinity of Charleston, S. C., 1834; by Gibbes, of the plants of Columbia, S. C., 1835; by Aiken, of the plants near Baltimore, 1836; by Lea, of plants collected in the vicinity of Cincinnati, after his death published by Sullivant. The fungi of the collection were examined by Berkeley.

Ravenel published a paper on the plants of the Santee canal, 1850, and Kirtland one on the climate, flora and fauna of the southern shore of Lake Erie, 1852.

Publications on single orders exist of Jos. Barratt, "Salices Americanæ" and "North American Carices," 1840; of Tuckerman, "North American Lichens," 1848; of Sullivant, "Musci Alleghaniensis," 1846, and "Bryology and Hepatology of North America," 1847; of Bailey, on "North American Algæ." 1848; of Curtis, on "North American Fungi," 1848, both in *Silliman's Journal;* of Dewey, "North American Carices," in *Silliman's Journal;* of Sartwell, "Carices Americæ septentrionalis exsiccatæ," 1848–1850 (158 species); of Alex. Braun (professor in Berlin, who died lately), "Equisetæ and Charæ," in *Silliman's Journal;* of Harvey (professor in Dublin, dead since 1866), "The Marine Algæ of North America," in Smithsonian Contributions, 1858, three volumes, with fifty plates.

The chief authority on North American fossil plants is Leo Lesquereux, a native of Switzerland, residing in Columbus, Ohio, who is besides a trustworthy judge of mosses, and compiled the catalogue of Arkansas plants in Owen's Geological Report. An important branch of science, the geographical distribution of American plants, is yet in its infancy. It requires a thorough knowledge of local floras in connection with the physical and climatological condition of each locality to get the right view of this matter. Some steps have been made in that direction, some

preparatory work has been done, but the main labor is left to the future. Prof. Gray published "Statistics of the Flora of the Northern U. S.," in *American Journal of Science and Arts*, 1856, which will promote the cause for that part of the country. Dr. J. G. Cooper published a good article on the distribution of the forests and trees of North America, in Smithsonian Report for 1858. As only the woody plants are here accounted for, the limits drawn cannot be intended as to separate botanical districts in general. Even for the forest plants the limitations admit of some corrections, but as a preliminary essay it is valuable.[1]

Here this sketch must be concluded, for two reasons—1, the newest botanical literature is so extensive, and partly published in so many different periodicals, that a private library is not sufficient for a survey of the whole; 2, the number of botanists has increased so much throughout the country, as is shown by Cassino's Naturalist's Directory, that it is rather difficult to winnow the chaff from the wheat, and to avoid offence by neglecting a man whose merits are worthy of mention.

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EDITORS' TABLE.

EDITORS: A. S. PACKARD, JR., AND E. D. COPE.

—— The Academy of Natural Sciences of Philadelphia, nearly four years since, made a number of changes in its organization as expressed in its by-laws. With but two dissenting voices, the academy concluded to place the direction of the museum, and the scientific work dependent on it, in the hands of thirteen professors, who were to perform the work previously entrusted to four curators. Experience had abundantly shown, what is indeed self-evident, that a general scientific museum cannot be obtained, arranged or controlled by four persons, however gifted; and further, in the history of the institution it had generally been the case that the four curators were not all selected from the original investigators or active scientists of the academy. It was thought

[1] Although published in 1860, yet, as the author has mentioned several works published later than 1850, we may here draw attention to the Flora of the Southern United States, containing abridged descriptions of the Flowering Plants and Ferns of Tennessee, North and South Carolina, Georgia, Alabama, Mississippi and Florida, by A. W. Chapman, M. D. The Ferns, by Daniel C. Eaton, New York, 1860. pp. 621.—EDITORS.

to be important that the control of the working material of the institution should be in the hands of those who do the work and give it its reputation; and further, that lectures should, from time to time, be delivered, which would constitute statements of the progress of science, as made by the workers of the academy and of the world at large. These propositions, whose reasonableness is so self evident, bringing the academy, as they would, into conformity with the usage of similar bodies throughout the world, were stoutly resisted by some of the members. As discussion proceeded, it became evident that without such an organization, or its equivalent, the title of "Academy" is a misnomer, and that nothing good could be expected of the club management under which it was conducted. It was shown that under this order the position of an expert *working in the institution* was an unenviable one; that free use of the museum exposed him to charges of misconduct by irresponsible and ignorant persons, and brought him in conflict with employés who recognized only the authority of the four curators. It was brought to view that the most profuse liberality and generosity to the institution afforded no protection from these wrongs, and that while gifts of the greatest value were gladly accepted, obstacles, often indirect but always effective, were thrown in the way of the use, by the donors, of these, and even of unpresented private property. It was shown that the arrangement and labeling of the collections were frequently entrusted to incompetent persons, and that the result was what might be expected; also that the museum was not keeping pace with the age, and that as a consequence, original work in connection with it had almost ceased. The result of the discussion was as stated, the adoption of the proposed re-organization, with only two dissenting voices.

One of the two noes came from the president, Dr. Ruschenberger. Although standing thus in opposition to the will of the academy, the services of this gentleman in the cause of science in raising money for the erection of the building the academy now occupies, were justly so appreciated by the members, that he was reëlected to fill the position for another year. A due sense of the generous action of the majority in thus electing an opponent to the highest position within their gift, if not sufficient to induce conformity to the republican principle of a support of the views of the majority, should at least have suggested a passive attitude towards their attempts to carry their wishes into effect. But the friends of progress were doomed to disappointment. A determination to stamp out the new measures was manifested by a few members, who, having abandoned legitimate opposition, adopted the weapon of the weak—personal defamation. By introducing damaging personalties, so that a full discussion was impossible prior to an election of officers, much injury to the interests of the institution, as well as injustice to private persons,

was done. The president was, by no means, clear of complicity in these proceedings, which, after the lapse of two years, received the emphatic condemnation of the academy by a vote in the proportion of two and a-half to one. In the meantime the new by-laws not only remained a dead letter, but additional changes were made which completely nullified them. The most important of these, by excluding the prospective professors from the council, rendered the positions untenable by men who value the prosperity of the academy. But this was simply a first step in the development of a new policy of the president's own conception, and for which he should have full credit, as expressed by himself.

Dr. Ruschenberger has stated verbally, that it was his opinion that the council of the academy would be better constituted without the membership of the specialists. He has also maintained, that the prospective professors should not be members of the council, because it is the duty of that body to "direct the professors when to lecture, where to lecture, and what to lecture about." He is credited with saying, that no "high science" can be looked for from such an institution, as it is a kind of high school, etc., etc.

We have here at last the opposition to the new organization crystallized, which we think to be a desirable consummation. Is the "Academy" to be an academy of original research in the sciences, or, shall we say, a trustee school, which will tolerate original research provided it be not too extensive or important? Shall the institution adopt a mediæval system which has been repudiated long since in many countries as regards universities, and which has no relation anywhere to academies of science? Is it necessary to say that an academy of sciences consists exclusively of a body of experts in science, and that under this established definition some of our officers have no claim to even membership in such a body? Are we to return to the days when learned men were the property of priests or the mere ornaments of the governing classes of society, subject to their dictation as to "where they shall lecture, when they shall lecture, and *what they shall lecture about.*" That is what the scheme of Dr. Ruschenberger amounts to, only substitute for priests and nobles a collection of generally worthy gentlemen, who know more of everything else than of science and its needs. That this scheme is in entire antagonism to the intention of the founders, whose object was original research, is sufficiently clear.

In direct opposition to the present domination of such views, and to prevent the perversion of the academy's property to uses not contemplated by its constitution, a resolution to make the prospective professors ex-officio members of council was largely and respectably signed and laid before the council, in hopes of its adoption. Among the signers may be mentioned the names of Leidy, Cope, Ryder, Dercum, Brown and Parker, well known in

Philadelphia scientific work. But the proposition was rejected by a quorum of the council, and the president has issued a report of the proceedings, which now lies before us. As it occupies nearly twelve octavo pages, it of course includes much besides the proceedings referred to, and is in fact a digest of the president's views on the subject. That such a document should be prepared, shows that its author has but a faint conception of the position which he occupies in relation to the opinions of the majority of members of the academy. An examination of its contents shows that his perception of the proprieties of discussion, both as a man and as an officer, is still less clear. We only allude to the gross inuendoes and slurs it contains, to state that some of the worst of them were added by the author after the formal authorization of the publication of the report of council, and that he thus commits an offence against ordinary propriety, and against the Society itself. Such is also the omission of the names of persons against whom some of these charges are leveled, which names were contained in the report as read. We think, however, that the publication will be, on the whole, useful to the academy's cause, as it indicates, in no doubtful way, the unfitness of its author for the position he occupies.

We, however, call attention to one subject, which, dressed up in various guises, has served, and still serves, as a scare-crow to some useful members. The proposition to create thirteen professors who shall be ex-officio members of council, does not disturb the present order, by which the general officers of the academy are ex-officio members of council. It simply places the experts of the institution on an equal footing in council with those elected by the academy at large, thus forming a body composed of what might be called senate and house combined. But Dr. Ruschenberger pretends to be alarmed for the safety of the property when entrusted to the care of the thirteen. We do not believe that any one else is apprehensive of danger, but if they are, we suggest that still greater risks attend the charge of the collections by equal or smaller numbers (say four, as at present) of persons, who are mostly unacquainted with the business. Secondly, the use of new material by thirteen men to the exclusion of the eight hundred and eighty-seven other members of the academy, appears to Dr. Ruschenberger, to be a monstrous injustice. Perhaps the doctor would approve a plan by which all these gentlemen might take turns at describing the mass of new species daily received at the hall of the academy; or the difficulty could be gotten over if the council would resolve that new species might be described several times.

But seriously, the president inverts the order of things absolutely. *The amount of new material coming to the institution obviously depends on the number of persons interested in bringing it there.* If such interested persons find that they have no rights

that any one is bound to respect, they will not bring it there; as is the case at present. And thirteen men who are interested, and who know how to obtain it, will certainly benefit the academy more, than four persons,[1] most of whom do not know new material when they see it, have no use for it, and do not know how to get it.

Finally, we suggest whether the professorship scheme would not go better if a chair of libel were added to the list. The only reason why this chair should not succeed would be, that the most eligible candidate could not then be a member of council, who would have the power to direct him "where to lecture, when to lecture and what to lecture about."

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RECENT LITERATURE.

GEOLOGICAL SURVEY OF CANADA.[2] — Owing to the separate paging for the several reports filling this volume, by which the process of printing has been hastened, it has appeared sooner than its predecessors. It is devoted mainly to interesting observations on the stratigraphy of the Quebec group, by Mr. Selwyn, who seems to discard the names Norian, Montalban, Taconian and Keeweenian, proposed by Dr. Sterry Hunt, and now in quite general use by New England geologists. Mr. G. M. Dawson reports at length on the geology of British Columbia, Mr. S. H. Scudder describing the fossil insects. The reconnaisance by Mr. Robert Bell of the west coast of Hudson's bay, gives us the first definite knowledge, so far as we are aware, of that interesting region. He claims that there is abundant evidence of the elevation of the land (or to use his own words, "that the sea-level is falling") at a comparatively rapid rate in Hudson's bay. "Since," he writes, "the Hudson's Bay Company's ports have been established at the mouths of the various rivers, there has been an increasing difficulty in approaching them with large craft. On the islands and shores all along the Eastmain coast, the 'raised' beaches are very conspicuous at all heights up to about three hundred feet immediately near the sea, but, no doubt higher ones would be found further inland. Drift-wood (mostly spruce) is found almost everywhere, above the highest tides, in a more and more decayed state the higher above the sea, up to a height of at least thirty feet, and in some places up to forty and fifty feet, above which it has disappeared by the long exposure to the weather. Judging by the rate of decay of spruce wood in this climate, its preservation in large quantities, during an 'elevation' of the land, or rather a fall in the water, to the extent of thirty

[1] This excepts the few cases where private persons or bodies are allowed control of their own collections deposited in the academy building.

[2] *Geological Survey of Canada.* ALFRED R. C. SELWYN, F.R.S., Director. Report of Progress for 1877–'78. Montreal, Dawson Brothers, 1879. 8vo, with maps.

feet, would indicate a change in the relative level of the sea, amounting to perhaps between five and ten feet in a century."

Boulder clays are abundantly developed, containing numerous shells characteristic of the Leda clays of the coast of Labrador. It appears that the white whale still exists in considerable numbers all along the coast, while "the walrus is killed by the Esquimaux, principally about the entrance to Hudson's straits and around the Belcher islands. In former years this animal is reported to have been seen occasionally as far south as Little Whale river. On the opposite side of Hudson's bay walruses are said to have been seen near Cape Henrietta Maria. The narwahl is occasionally killed by the Esquimaux in the northern part of Hudson's bay. In the spring, soon after the shore ice disappears, the polar bear occasionally comes ashore on Long Island and the smaller islands between it and Great Whale river. In the winter they have been known to range as far south as the head of James' bay." The climate of the west coast of Hudson's bay in the Nelson river region is milder than that of the opposite coast, and that of the region about the Norway House is fully as good as that of the Province of Manitoba. The subsoil in places is frozen through the summer, and it is possible that toward York Factory it is permanently frozen.

The volume closes with reports by Messrs. L. W. Bailey and R. W. Ells on the Pre-silurian and Cambrian rocks of Southern New Brunswick, and on the superficial geology of New Brunswick, by Mr. G. F. Matthew; on the geology of Cape Breton, by H. Fletcher, with others on economical geology.

Morse's Shell Mounds of Japan.[1]—Not only has Japan an university very fully manned with American, English and German instructors, but her desire to make it a genuine university, by contributing to the advancement of science, is made evident by the publication of a volume giving the results of researches carried on by the professors and students. The first contribution is to the new science of anthropology by a people which has but recently thrown off the habits of a semi-civilized race and adopted the modes and sciences of those which call themselves civilized. This memoir is timely in its issue, for with a tolerable acquaintance with prehistoric archæology in Europe, America and parts of Asia, such as we now possess, comparative studies on the prehistoric remains of a people so old as the Japanese, and with such an interesting geographical position, would prove highly suggestive and of very considerable value. And here it may be observed, parenthetically, that it is claimed by the author, "that there is no other country in the world where so great a number of gentlemen

[1] *Memoirs of the Science Department, University of Tokio, Japan.* Vol. 1, Pl. 1. Shell Mounds of Omori. By Edward S. Morse, Professor of Zoölogy, University of Tokio, Japan. Published by the University, Tokio, Japan, 2539 (1879). 8vo, pp. 36, with 18 plates.

interested in archæology can be found as in Japan." Indeed there is a native archæological society in existence which holds regular meetings.

The Omori mounds lie six miles from Tokio, about half a mile from the shores of the Bay of Yeddo, and as shell mounds are naturally cast up near the shore, this indicates that the land has been elevated since their formation. These mounds differ from those of Denmark and New England by the great amount of pottery contained in them, by the great scarcity of stone implements, and by the absence of arrow-heads, spear-points and other pointed implements of stone, not a single arrow-head, flake or chip having been found after prolonged search, though rude stone hammers, celts and rollers, and instruments of bone occurred; but any ornaments for personal adornment, such as are worn by the Ainos, were entirely absent. While the remains of the monkey, deer, wild boar, wolf and dog occurred, the human bones were found to have been broken, "either with the object of extracting the marrow or for convenience of cooking in vessels of too small dimensions to admit them at length," while the bones were, in some cases, "strongly marked with scratches and cuts." These evidences of cannibalism are paralleled by those of the aborigines of Florida. Flattened tibiæ also occurred. The author also compares the shells found in the mounds, and discovered that much as on the coast of New England and Florida, they are now less abundant and smaller. While changes in the relative proportions of the shells of certain molluscs have taken place, the modifications in the relative size and proportions of certain species being considerable, and seeming to indicate "either that species vary in a much shorter time than had been supposed, or else that deposits presenting these peculiarities have a much higher antiquity than had before been accorded them." The differences seemed to be decided, though still within specific limits, and to have been produced at a minimum of 1500 to 2000 years, Japanese history extending back thus far.

The plates, printing and manufacture of the book is of Japanese origin, a Japanese as well as an English edition having been printed.

Growth as a Function of Cells.[1] — Under this title Mr. Minot discusses the subject of the increase of bulk, weight, etc., which attends the development of an individual organism from the one-celled egg-stage to maturity and death. The exponential formulæ presented, expressing the rate and consequences of growth, are just about as unsatisfactory as they well can be, and, while we would not for a moment doubt the accuracy of Mr. Minot's facts, the attempt to express the laws of growth, which

[1] *Growth as a Function of Cells.* By Ch. Sedgwick Minot. Proceedings Boston Soc. Nat. Hist., 1878–79. Vol. xx, Pt. ii, p. 190.

are themselves determined by the incidence of variably potent forces which again interact variably, producing variable resultants, the propriety of expressing biological equations by x, y, generations by n, and their variables by $\pm n$, powers of these or any other desirable arbitrary symbols, becomes apparent. The results to science of this method of treating the subject, while perfectly proper and right if a person chooses so to state them, may be fairly questioned.

There seems just now to be a mania amongst biologists for re-naming things when they remodel old definitions. Although Huxley may define the *individual* as the result of the development of a single egg, and Haeckel define and call it a *person*, a *virtual* or an *actual bion;* our author now under notice, thinking that, because it has recently been discovered that the ovicell, by impregnation, becomes blended with the spermatozoön, justifies him in coining a new term derived from that much-tortured Greek word from which so much *bio*logy has been extracted, for re-christening the individual under the name of *biad*. The nominal rubbish of scientific literature is acquiring huge proportions; for we already have for the cell, *plastid*, *protoplast*, *bioplast*, *amœboid;* and for special forms of it, terms too many to catalogue here. On this ground the proposition to re-name an old thing is ill-advised, and it may be doubted whether *zygote*, the name proposed for the result of the fusion of the male and female cell elements in certain plants, by Strasburger, may not properly supercede *biad*, while the word *gamete*, proposed by the same author, will answer all practical purposes in designating the reproductive elements of separate sexes. When one is worried with getting at the import of some recently coined term, so often needlessly imposed by some of the evolutionary school of scientific thinkers, Haeckel and his followers especially, it is refreshing to turn to the pages of Darwin or Spencer, often to find the same questions treated in much better and plainer every-day English.—*J. A. R.*

Williamson's Fern Etchings.[1]—The dual character of this fine work makes it no less valuable to the amateur fern student and advanced pteridologist than to those who admire ferns for their beauty alone, as by adopting the geographical range of "Gray's Manual," and accompanying his plates with descriptive text, the author, while professing only to present a series of life-like fern etchings, has really given to us a complete hand-book of all the species found growing in the Northern, Middle and Eastern States, and, in the present edition, the Dominion of Canada.

The clear, concise descriptions and faithful representations of the ferns themselves, will make this book an invaluable and indis-

[1] *Fern Etchings.* By John Williamson, author of the "Ferns of Kentucky." Published by John P. Morton & Co., Louisville, Ky, 1879. 2d edition, 70 illustrations. Price $7.50.

pensable companion to fern collectors; while those who look upon ferns as beautiful objects to be admired rather than studied, will find enough in these charmingly executed etchings of Mr. Williamson to satisfy and delight them.

The etchings, which are printed direct from the original copperplates, and in the present edition by the author himself, are beautiful examples of the author-artist's special work, and will add greatly to his reputation as a faithful interpreter of fern life.

The desire to obtain copies of Mr. Williamson's fine etchings printed direct from his own plates, has led to the publication of the present work, and, as the number of copies printed must necessarily be limited on account of the expense of the etchings, those wishing copies will need to send for them early. No fern library will be complete without a copy.—*G. E. Davenport.*

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GENERAL NOTES.

BOTANY.

MOTHS ENTRAPPED BY AN ASCLEPIAD PLANT (PHYSIANTHUS) AND KILLED BY HONEY BEES.—Towards the last of September, Mr. John Mooney, of Providence, an observing man, brought us a stalk of *Physianthus albens*, an Asclepiad plant originating in Buenos Ayres, with the bodies of several moths (*Plusia precationis*) hanging dead by their proboscides or maxillæ. It was found that the moths had, in endeavoring to reach the pollen pockets, been caught as if in a vise by one of the opposing edges of the five sets of hard horny contrivances covering the pollinia. A few days after, Mr. Everett A. Thompson, of Springfield, Mass., wrote us, that he had a plant of the same species which had caught a number of moths of several species, and that in some cases only the heads and tongues of the moths were left, and he attributed this dismemberment to birds, but wrote in the same letter that his father had seen bees sting the moths while alive and struggling. He sent me one of the moths, which proved to be a *Plusia precationis*, the same species as we had observed in Providence, and a honey bee (*Apis mellifica*) which had been seen by his father to attack the moths, and which had a pollen mass of the same plant attached to one of its fore legs. On writing Mr. Thompson that his father's observations were quite new, the hive bee not being known to be carnivorous, beyond its well-known habit of stinging and killing the males of its own species and the bee moths invading its cells, his father, Rev. L. Thompson, of North Woburn, Mass., a careful observer, kindly prepared the following statement:

"I cannot undertake to give an account of my observations of the plant, moths and bees, concerning which inquiry is made, from the standpoint of a scientist, which I do not claim to be, but after pretty close watching, continued for many days, I feel quite confident of the general correctness of the following statement:

"Early in September, of the present year, as I made one of my daily visits to the plant, to me unknown before, the *Physianthus albens*, or Arauja, I noticed among the many moths that had been caught in the flowers, a considerable number of tongues still in the traps, while all, or nearly all, else belonging to the recent captives had disappeared. While I stood gazing, my attention was arrested by two or three bees buzzing immediately around as many entrapped moths that were alive and struggling to get away. Every moment or two, the bee suddenly and furiously darted upon the prisoner and seemed to me to sting it despite its desperate efforts to escape. This onset was generally instantaneous, but was repeated again and again, and, after the moth became still and apparently lifeless, the bee settled upon it, and, if my eyes did not greatly deceive me, began to devour it. I had previously noticed the tongues but supposed the bodies of the moths had been eaten by birds, though I had not actually seen it done. I cannot therefore positively assert what seemed to me the fact at the time, though I had no other thought, and the fact that so many of the moths had actually disappeared, leaving only their tongues, and, in some cases, other fragments of their bodies, in the shape of legs clinging to bits of casing or skin, satisfied me that the bees had really feasted on animal food as well as upon the nectar of surrounding flowers.

"I did not suppose it to be the honey bee at the time, but a kind of wasp, such as or similar to that whose nest I had sometimes found in sodded banks or terraces and looked upon as an architectural wonder. Yet I did not examine it, and can only say that I saw many, or supposed I did, upon a bed of Nasturtiums and other flowers, a few feet distant from the Physianthus.

"I think I have found as many as three or four different kinds of moths upon the plant, besides numerous small black flies which, unlike the moth, go down *bodily* into the flower.

"L. THOMPSON.

"*North Woburn, Oct. 29, 1879.*"

Upon writing Dr. Hermann Müller in reference to these facts, he replied as follows:

"Lippstadt, Nov. 10, 1879.—*Physianthus albens* has been observed by Delpino as being visited by humble bees and fertilized by their proboscis. It is a new and very interesting fact that *Plusia precationis* is caught by the flowers of this plant and has been found dead suspended by its proboscis. About carnivorous habits of bees, my brother Fritz, in south Brazil, has observed that honey bees (but I do not remember for the moment whether Apis

or stingless Brazilian honey bees) licked eagerly the juice dropping from pieces of flesh which had been suspended in order to be dried in the open air. Nothing else as far as I know has ever been published on the carnivorous habits of bees; I hope, therefore you will soon publish your very interesting observations."

We have also received the following letter from Mr. Darwin, dated Down, Beckenham, Kent, Nov. 23d. "I never heard of bees being in any way carnivorous, and the fact is to me incredible. Is it possible that the bees opened the bodies of the Plusia to suck the nectar contained in their stomachs? Such a degree of reason would require repeated confirmation and would be very wonderful. I hope that you or some one will attend to the subject."

We have also received the following note from Prof. Gray in reference to the subject: "It has long been familiar, and must several times have been recorded, that moths or butterflies and other insects are caught by getting their tongue, proboscis or legs into the chink between adjacent wings of the anthers in *Physianthus* or *Arauja albens*, and *Asclepias*, etc. The anther-wings are very rigid, the groove between them narrows gradually upwards, so that when a leg or proboscis is engaged, an upward pull only fixes it more securely, and the unhappy insects seem rarely to pull backward or downward, which is the only way to get disengaged. As to the rest of your account I know nothing; and should say that the observations need, if not 'repeated confirmation,' at least some confirmation by an entomological observer."

It appears from the fact that the single worker bee received had a pollen-mass attached to one of its fore legs, that it visited the plant originally for the sake of its nectar. For what purpose did it attack, kill the moths and, as is claimed, "devour" them? We publish the observations of Mr. Thompson and the comments upon them, with the hope that the subject will receive attention next summer.

Since this note has been put in type, Prof. A. J. Cook, of the Agricultural College of Michigan, well known as an apiarian of experience, informs us that *within the hive*, honey bee workers in killing the drones tear them in pieces with their mandibles rather than sting them, and that he has seen them thus kill a humble bee that had entered the hive; it thus appears, what we judge will be quite new to entomologists, that the honey bee uses its mandibles, at least on some occasions, as weapons of attack, quite as much as the sting; this would also corroborate the exactness of Mr. Thompson's observations.—*A. S. Packard, Jr.*

Prof. Heer on Sequoia.—At the recent meeting of the Helvetic Society of Natural Sciences, Professor Heer read a paper in the Botanical section, on the palæontological history of *Sequoia*. This genus is now represented by only two distinct species, forming the celebrated forests of big trees in California, and known to

botanists as *S. sempervirens* and *S. gigantea*. Prof. Heer finds that the genus attained its greatest development during the Tertiary epoch, though it was before largely represented in the Cretaceous. Between the two types above named, palæontological collections have furnished as many as 24 fossil species; of which number 14 belong to the Tertiary, and 10 to the Cretaceous. The lower chalk alone furnishes 5, two of which, strange to say, are closely similar to the surviving species (if not identical). *Sequoia* has not, as yet, been found in Jurastic formations, though these are rich in Coniferæ.

Botanical Notes.—The *Bulletin* of the Torrey Botanical Club for October, contains notes on the flora of the Lake Superior Copper region, by A. Hollick, and descriptions of the new fungi, by F. Baron Thueman.——In the *Botanical Gazette* for November, C. H. Peck describes new species of fungi; T. Meehan remarks on Viscidity as a seed-distributor; while Dr. Gray notices *Vaccinium macrocarpon*, var. *intermedium* of the Columbia river.——To the *California Horticulturist* for November, Mr. B. B. Redding contributes a note on the valuable edible qualities of the camass root, which is extensively used as an article of food by the Indians of the western Territories and the Pacific slope.——In Trimen's *Journal of Botany* for November, Mr. S. H. Vines describes the alternation of generations in the Thallophytes. The recent deaths of Mr. John Miers in the 72d year of his age, and of Fenzel, the Austrian botanist, are announced.

ZOÖLOGY.[1]

Changes in the Shell of Limnæa megasoma produced by Confinement.—In a paper by R. P. Whitfild, read at a late meeting of the Boston Society of Natural History, and entitled, "Description of the animal of *Lymnæa megasoma* Say, with some account of the changes produced by confinement in aquaria and under unnatural conditions," Mr. Whitfield states that he succeeded in keeping alive a specimen of this species in an isolated position in an aquarium in his house at Albany. These specimens were obtained at Burlington, Vt., in the summer of 1867. Two of them speedily died, but the third one survived the change to its new abode until the following spring. In February it laid eggs supposed to have been unimpregnated. After twenty days the animals escaped from the eggs. In the spring of 1868 many of these were removed to localities in the vicinity of Albany. During February, 1869, those of this lot still remaining in the aquarium deposited their eggs, and again during the early part of the following summer.

From the winter brood, specimens were reared which deposited eggs in the early part of 1870.

[1]The departments of Ornithology and Mammalogy are conducted by Dr. Elliott Coues, U. S. A.

The first and second generations were each smaller than the parent stock, and this last, a third generation, had a shell only about four-sevenths as long as measured by the figures.

The animals of Lymnæa are perfect hermaphrodites, combining in each individual both male aud female organs, therefore it is not likely that the original ancestor of Mr. Whitfield's group was a deficient specimen. Nevertheless, besides the diminished size and spire, Mr. Whitfield found that the male organs had disappeared and the liver become considerably reduced in size. A diœcious species had, therefore, in all probability become a monœcious one on account of its removal to the aquarium.

This paper reminds us very strongly of the researches of Carl Semper upon Lymnæa, in which he shows that the supply of food and other things being equalized in a number of aquaria, that the size of the shells depends upon the temperature. A low temperature being inimical to the development of the largest size in any species.

In this case Mr. Whitfield, who is a palæontologist well known to workers in his own field, did not undertake his researches with the idea of conducting an experiment, but has, nevertheless, brought out a very similar series of modifications. Curiously enough, however, he took a species which reaches a very large size in northern waters, and introduced it to the almost tropical climate of a home aquarium.

Mr. Whitfield has certainly been very fortunate in leading the way into this field of research in experimental zoölogy with so suggestive a paper.—*A. Hyatt.*

Influence of Poisons on Crustacea.—The influence of some of the principal poisons on crustacea has lately been experimented on by M. Yung. The animals treated were the crab and lobster. It was found that curare acts on these animals in the same way as on vertebrates, but with much less power; it produces difficulty of movement, which may go the length of complete paralysis. Strychnine, again, acts with extreme violence, causing strong (though temporary) tetanus. The muscular exhaustion is quicker than in vertebrates. A crab will live a long time in water charged with sulphate of strychnine, which shows that the poison is not absorbed by the branchiæ. Sulphate of atropine never caused death. The animal seems to eliminate this poison after a period of debility, preceded by tremblings. Digitaline quickens (shortly), then renders slower, the heart's movements. The action of nicotine is characterized by extreme rapidity. This poison is as violent for crustacea as for vertebrates.

Difference in the Habits of Scalops aquaticus and Scapanus americanus.[1]—A valued correspondent, Mr. Elisha Slade, of Somerset, Mass., finds decided differences in the habits of the

[1] For this latter name see American Naturalist, xiii, 1879, p. 189.

common and the hairy-tailed moles. According to his observations, the latter prefer rather dry ground, while the former is sufficiently fond of low moist soil to merit its specific name, *aquaticus*. Though the common mole is not aquatic in the sense a mink or muskrat is, it voluntarily enters the water and procures a part of its food in that element, such as water bugs, worms, &c. It is known in Mr. Slade's locality as the marsh or water mole, the hairy-tailed being called the upland mole.—*Elliott Coues, Washington, D. C.*

The Cotton-worm Moth in Rhode Island.—On the evening of the 30th of September, a specimen of *Aletia argillacea* flew into my study, in Providence. The moth was in a perfectly fresh condition and bore every appearance of having quite recently emerged from the chrysalis. Its appearance certainly did not bear out the theory that all the northern individuals fly northward from the cotton belt. Several years ago I captured, in August, on Coney Island, in Salem harbor, Massachusetts, several fresh specimens, which indicated that they had originated not far from, if not on, the little islet on which they were flying in the day time.—*A. S. Packard, Jr.*

Notes on Phyllopod Crustacea.—We have received from Florida, through Mr. C. Gissler, a new Branchipus-like form which may be called *Streptocephalus floridanus*. While the females of this genus do not present decided diagnostic characters, the male is distinguished by the form of the claspers, whose tips, when drawn forcibly straight out, will reach to the end of the last pair of feet. The two basal filaments are as in *S. texensis* Pack.; of the forceps at the end of the claspers, the filaments are much shorter and smaller than in *S. texensis*, so much so that there is no need of confounding the two species, and besides in the Floridian species the processes are less broad and flat, and the inner of the two blades of the forceps have but one instead of two teeth. While of the same size as *S. holmani*, the male claspers are very much larger, and they are longer than in *S. watsoni* Pack., from Kansas; with the latter species it need not be confounded. It approaches *S. texensis* nearest in the robustness of the body, in the form and size of the caudal appendages, which are much stouter than in the other two species, and equal, in length, the three last abdominal segments. It seems to approach *S. similis* Baird, which inhabits St. Domingo, but that species is not described with sufficient exactness to enable us to compare it properly.

From Mr. Gissler we have also received specimens of *Limnetis gouldii* Baird, found by him in March and April, on Long Island. From Mr. R. P. Whitfield we have received specimens of *Estheria watsoni* Pack, collected by Dr. C. A. White on the Vermilion river, Colorado, in company with *Lepidurus bilobatus* Pack.—*A. S. Packard, Jr.*

THE WHITE BELLIED SWALLOW (*Iridoprocne bicolor*).—In the NATURALIST for November, 1879, p. 706, Mr. Allinson notes having seen swallows, at Beach Haven, N. J., which he took for the bank swallow, *Coytle riparia*, and that he was surprised to find in their excrement the seeds of the Bayberry. I think there can be no doubt that the species was the white-bellied swallow, *Iridoprocne bicolor*, which does feed in part on the waxy fruit of *Myrica cerifera*. Seventeen years ago I kept the *I. bicolor* as a pet, giving it the freedom of a room, in one corner of which I kept a bush of the bayberry, or American myrtle, changing it, as soon as the berries were picked off. I also fed it with house flies, of which it was very fond. The bayberry is a hard nut-like seed, and its cinereous or whitish covering of wax is a mere pellicle. As food for the birds, it amounts to little, unless it can have it in large quantity and very often. If, so far as known, the *bicolor* is exceptional among the swallows in this matter of a mixed diet, I think it is equally so in its habits, for it is far less aërial, and more terrestrial, than the other members of its tribe. Of the nearly one hundred species of swallows in the world, it seems to me that *I. bicolor*, which is peculiarly American, is an eminently specialized type.[1]—*S. Lockwood, Freehold, N. J.*

VIBRATION OF THE TAIL IN RACERS.—In the September number of the NATURALIST, Mr. F. H. King states he has observed the fox snake (*Coluber vulpinus* Cope) making a buzzing noise by rapidly vibrating the tail. In the November number, Mr. C. Aldrich makes a similar statement in regard to *C. obsoletus* var. *confinis* B. & G.; I have, in a number of instances, observed the same habit in *C. emoryi* Cope, which is a common species with us. I have never known the noise to be made, unless his snakeship was first directly disturbed or teased. The sound is usually made by elevating from three to four inches of the tail at an angle of near 70° from the horizon, then giving it a very rapid lateral motion. When it strikes leaves or other loose objects, there is, in addition to the buzzing sound, the rattling noise of the objects struck, proving that the first sound is probably produced by the rapid vibrations of the tail in the air. As this habit has been observed in three of the six species of this genus, may it not be true of all belonging to it?—*J. Schneck, Mt. Carmel, Ill.*

FORK-TAILED EUMECES FASCIATUS AND THE VARIABLENESS OF THIS SPECIES.—During the last few years the periodical literature has been quite prolific with notes on monstrosities in the animal kingdom. Prof. J. Wyman reported a specimen of the common garter snake (*Eutænia sirtalis*) with two heads. Mr. J. W. A. Wright gives an account of a gopher snake (*Pityophis* sp. ?); Dr. H. C. Yarrow describes a specimen of *Ophibolus*

[1] Mr. Lockwood's remarks bear out the advisability of recognizing for this species the genus *Iridoprocne*, lately proposed by us, Birds, Colorado Valley, p. 412, 1878. —E. C.

gluteus, and Mr. J. S. Kingsley mentions a specimen in Williams College museum, in all of which there are two heads. Mr. J. S. Kingsley also mentions a five-legged frog (*Rana palustris* Le Conte) taken near Rochester, N. Y.; and Mr. J. Stauffer also mentions a similar specimen of the same species taken near Lancaster, Pa. In the *Oölogist* for August, 1879, mention is made of two specimens of ruffed grouse (*Bonasa umbellus*) one of which had ten and the other twelve toes. Mr. W. N. Lockington gives an account of a one-toed deer, and finally, Dr. E. Coues describes a race of one-toed hogs.

To the above I wish to add, that I have seen three specimens of our common blue-tailed lizard (*Eumeces fasciatus* S.) with forked tails. The specimens were all taken near New Harmony, Ind. Two are now in the collection of Mr. J. Sampson, of that place. The two prongs are near the same length, and as I remember, near three inches in length in all the examples seen. The two prongs form an acute angle of near 35°, and are attached to a short stub of the natural tail, which appears to have been broken off. I have also seen a number of specimens in which part of the tail was gone. Is it not probable that in the forked-tailed examples, this member was first broken off, and in the restoration this unnatural growth was assumed? While I am speaking of *Eumeces fasciatus*, I will mention the exceeding variableness of this species. From the small, blue-tailed, striped lizard, three inches in length, to the large, ruby-headed, copper-bellied specimen, twenty inches in length and no stripes at all, every conceivable grade is found. A comparison of twenty-eight specimens show ten well marked stages, each of which, taken alone, would make a good species.—*J. Schneck, Mt. Carmel, Ill.*

Zoölogical Notes.—The *Proceedings* of the U. S. National Museum contain a number of descriptions of marine invertebrates, by Prof. A. E. Verrill; with notes on New England Isopoda, by Mr. Oscar Harger. The material was collected by the U. S. Fish Commission.——In the *Proceedings* of the Boston Society of Natural History, Vol. 20, Mr. W. H. Patton gives a synopsis of the New England species of Colletes.——In the *Canadian Entomologist* for November, Mr. W. H. Edwards describes the egg, larva and chrysalis of *Argynnis idalia*. It is stated that Prof. Comstock, Entomologist of the Department of Agriculture, is endeavoring to prepare a biological collection of insects on such a scale and in such a manner as shall be a credit to the government. Special attention has been paid, the past year, to insects feeding on clover, the collection now containing over fifty species known to be destructive to this valuable crop.——A catalogue of the beetles of Japan, by G. Lewis, enumerates 2227 species. These represent many European genera, and in many cases are specifically identical with European forms.——We have received an

essay by Dr. Hermann Müller on protective mimicry in German insects, with some excellent cuts.——Mr. H. J. Carter, having already published an article on the probable nature of the animal, of Stromatopora, and a second on its mode of growth, prints a third paper on the structure of this fossil, and shows its relation to the Hydractinia, in the *Annals and Magazine* for October. In the November number he discusses the nutritive and reproductive processes of sponges. Carter and Lieberkühn have shown that Infusoria and particles of Algæ are taken in as food by the cells of the ampullaceous sacs, whether the cells are ciliated or not, while Metschnikoff has shown that the cells of the parenchym (mesoderm) also are alimentary cells. Thus every part of the spong-parenchyma is capable of enclosing nutritious material and digesting it.

ANTHROPOLOGY.[1]

ANTHROPOLOGICAL NEWS.—We are pained to hear of the death of Mrs. Rev. Stephen Bowers, wife of the eminent archæologist of Santa Barbara, California. She was devoted to her husband's labors, accompanying him in all his expeditions, and was herself an intelligent collector.

We have received from the editors of the Journal of the Victoria Institute, four pamphlet copies of papers from that publication bearing the following titles: The Ethnology of the Pacific, by the Rev. S. J. Whitmee; The caves of South Devon and their teaching, by J. E. Howard; The contemporaneity of man with the extinct mammalia, as taught by recent cavern exploration, and its bearing upon the question of man's antiquity, by Thomas Karr Callard; The lapse of time since the Glacial epoch, determined by the date of the polished stone age, by J. C. Southall.

Prof. George M. Dawson is the author of a pamphlet, reprinted from the *Canadian Naturalist*, entitled, Sketches of the past and present condition of the Indians of Canada. The Indian population of the Dominion is set down at 100,000.

Dr. Gustav Brühl sends to the Smithsonian Institution a pamphlet of sixteen pages, entitled, Aztlan-Chicomoztoc, eine ethnologische Studien. New York, Cincinnati and St. Louis, printed by Berziger Brothers.

Two very interesting brochures from the pen of Prof. Boyd Dawkins have reached us. One of them treats of the range of the mammoth in space and time, and appeared in the Quarterly Journal of the Geological Society for February, 1879. The other is upon our earliest ancestors in Britain, constituting No. 6 of Science Lectures for the People, and was delivered in Manchester, Jan. 18, 1879.

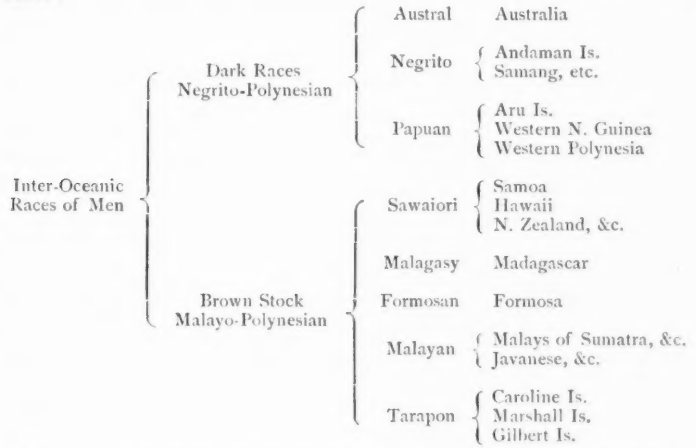
The *Journal of Anatomy and Physiology*, Vol. XIV, contains a paper, by Prof. W. H. Flower, on the scapular index as a race character in man.

[1] Edited by Prof. OTIS T. MASON, Columbian College, Washington, D. C.

The May number of the *Journal of the Anthropological Institute* contains the following papers: Some American illustrations of the evolution of new varieties of man, by Dr. Daniel Wilson; A revised nomenclature of the Inter-oceanic races of man, by Rev. S. J. Whitmee; Ethnological notes on the Motu, Koitapu and Koiari tribes of New Guinea, by Rev. W. G. Lawes; Notes on a skeleton found at Cissbury, April, 1878, by Prof. Geo. Rolleston; Illustrations of the mode of preserving the dead in Darnley island and in South Australia, by Prof. W. H. Flower. On page 402 is the address of the retiring president, giving an abstract of the work done during the year.

Dr. Wilson's paper in the *Journal* is devoted to a subject upon which he has bestowed a great deal of thought, the preservation of our aborigines, not by legislation but by a species of natural selection, through which a new race of men is being produced between the white race and the aborigines. The introduction of the black race and the Chinese increases the complexity of the problem and awakens some of the most curious questions in anthropology.

The communication of Mr. Whitmee is important, not only on account of his long familiarity with the Polynesian races, but also for the discussion which followed it. There are two broad and very distinct divisions of these people, the *dark* and the *brown* races; the dark occupying Australia, the Andaman islands, portions of the Indian archipelago and Western Polynesia; the brown being found in Madagascar, the Indian archipelago, Formosa, Northwestern and eastern Polynesia, together with New Zealand. Mr. Whitmee's division of these races is represented in the following table:



Mr. Wallace, who contributes the volume on Australasia and

Polynesia to Stanford's Compendium of Geography and Travel, and Prof. Flower, objected to several of the new appellations given by Mr. Whitmee. The map illustrating this paper will be found in the February number of the *Journal.*

The seventh part of *Anales del Museo Nacional de Mexico* is entirely devoted to Archæology, and contains the following papers: Códize Mendozino: Ensayo de descrifacion geroglifica, by Sr. D. Manuel Orozeo y Berra; Cosmogonia Azteca, by Prof. G. Mendoza; La Piedra del Sol: segundio estudio, by Sr. D. Alfredo Chavero; El Congreso Internacional de Americanistas en Europa y el cobre entre los Aztecas, by Sr. D. Jesus Sánchez; Anales de Cuauhtitlan.

Vol. 1, Part 1, of the Memoirs of the Science Department, University of Tokio, Japan, is devoted to the Shell Mounds of Omori. The author, Prof. Edward S. Morse, having for years studied shell heaps in Maine and Massachusetts in company with Prof. Jeffries Wyman and Prof. F. W. Putnam, was well qualified for the examination of these remains, and has made good use of his opportunities.

These mounds possess those common characteristics which distinguish shell deposits throughout the world. They have, likewise, the following special marks: 1. The presence of enormous quantities of pottery, of many different shapes, and of an almost infinite variety of ornamentation. 2. By the great scarcity of stone implements, and the absence of arrow-heads, spear-points and other pointed implements of stone. Not an arrow-head, flake or chip has been found by the various parties that have been there in the interests of the university. 3. The men of the Omori period were also cannibals. 4. Peculiar clay tablets or amulets. The pottery is minutely described and illustrated by fifteen double lithographic plates. In form and marking it resembles in a striking manner the fragments in the Latimer collection, figured in the Smithsonian Report for 1876. The tablets are of the finest clay, light colored; two of them have designs in relief, with depressed areas; on the others the figures are cut on a flat surface. The author ventures a comparison with American tablets, but is not able to reach any definite conclusion.

The opinion of cannibalism is founded on the same evidence as is offered by Prof. Wyman, but as savages break human bones for other reasons than a design to eat the flesh, the theory must take its chances with the rest. With much diffidence we would call Prof. Morse's attention to Le Moyne's plate 15, descriptive of the Indians occupying, in 1564, the very spot where Prof. Wyman found his evidences of cannibalism. "When a battle was fought the victors seized upon the enemy and mutilated their bodies in the most brutal manner. With cane knives the arms and legs were cut around and then severed from the body by blows upon the bones from wooden cleavers. The head was also cut around

with these knives, just above the ears, and the whole scalp jerked off. These were then rapidly smoked over a fire kindled in a small round hole, and borne off in triumph towards home, together with the arms and legs, suspended upon spears." Upon arriving at home they suspended these mangled limbs and trophies and danced around them in honor of their victory. Again, in arranging the Wilkes collection for the National Museum, I was struck with the great number of spear-points made of human bones. The question occurred to me then, and has been revived by Prof. Wyman, whether any magical effect would be attributed to spear-points made of the bones of a brave enemy. The absence of pointed bone in Omori would, of course, exclude the spear-point or implement theory. In conclusion, we consider Prof. Morse's memoir one of the most important contributions to archæology for the year 1879.

Numbers 3, 4 and 5 of *Materiaux* contain the following papers of interest to general students: Les pierres a bassin et les rochers a écuelles dans la Lozère, by G. de Malafosse; A Review of Evans' Ancient Stone Implement in Great Britain; Palæo-ethnological bibliography for the year 1878, by L. Pigorini; The Tenevières of the Swiss lakes, by Dr. Forel; The latest archæological publications in the North, the Archæological Society of Finland, by E. Beauvois; Upon the origin of domestic animals, by G. De Mortilet; New anthropological publications in the German language; Study upon ring-money and its use among the Germans, by Dr. Much. The article by Dr. Forel upon the *Tenevières* of the Swiss lakes is a very important one indeed. In M. Desor's classic work upon the palafittes of Lake Neuchâtel, the author describes certain little submerged stone mounds, formed, apparently, by heaping rocks around the bases of piles. When the lakes subside, the mounds form true islets. Dr. Forel's article is to show that many of these are of geological formation, being the natural consequence of a talus forming at the foot of a bluff.

GEOLOGY AND PALÆONTOLOGY.

Thickness of the Ice Sheet on its Southern Edge.—At the Saratoga meeting of the American Association for the Advance of Science, Professor J. C. Smock spoke of the surface limits of thickness of the Continental glacier in New Jersey. The existence of a great terminal moraine and a southern limit to the glacial drift in New Jersey and the adjacent States, were pointed out to the author in 1876, by Professor Geo. H. Cook. In that year the southern limit of the glacial drift was traced across the State from South Amboy to a point on the Delaware river, near Belvidere. Details were given of further investigations in tracing this line. The paper considered two questions:—What was the thickness of the ice-sheet along its southern margin; and what

was the rise of its upper slope northward. The terminal moraine represents both materials carried forward under the foot of the glacier, and also the earth and stone carried on its surface and dropped in a confused mass as it melted and retreated northward. These accumulated heaps may in places have equaled in height the greatest thickness of the glacier front, although in general the moraine would fall short of the height of the glacier. As we see it, this terminal moraine raises greatly in height from point to point. It is possible to get at a minimum estimate of the thickness by considering the heights of some of the hills in the moraine. It is safe to conclude that the ice front of the great glacier was from 200 to 400 feet in thickness. A careful exploration of that part of New Jersey, which is north of the terminal moraine, has thus far failed to discover any peaks or crests which show no marks of a glacier.

WERE THE ICHTHYOSAURS VIVIPAROUS?—This is a question which Prof. Seeley sought to answer in a paper submitted to the Geological Society at a late meeting. From time to time specimens of Ichthyosaurs have been found, with the remains of small saurians preserved inside the body-cavity. Against the supposition that these small ichthyosaurs had been devored by the larger ones, it may be urged that their state of preservation is markedly different from that of the remains of food, such as the indigested residuum of fish, which are not unfrequently found in the stomach of the Ichthyosaurs. Moreover, the position of the small skeletons in relation to the larger ones, with which they are associated, is tolerably constant, and is such as to strengthen the supposition that the relationship is that of offspring to parent. From these and other considerations, Prof. Seeley concludes that the Ichthyosaurus must have been viviparous.—*Academy.*

MIOCENE FAUNA OF OREGON.—Prof. Cope recently read a paper before the American Philosophical Society, describing additional species from the Truckee Miocene of Oregon. Several of these were Rodentia, one of which was referred to a new genus, under the name of *Paciculus*. Four were *Carnivora*, two *Canidæ* and two *Felidæ*. A new genus *Hyænocyon* was proposed for the *Enhydrocyon basilatus*, with the following dental formula: I. $\frac{3}{3}$; C. $\frac{1}{1}$; Pre-m. $\frac{4}{3}$; M.—. The genus *Merycopater* was shown to be an *Oreodont* with deficient superior incisors. A new genus of *Oreodontidæ* was described under the name *Colorcodon*, with the following characters: A wide diastema in both jaws. I. $\frac{2}{3}$; C. $\frac{1}{1}$; Pre-m. $\frac{3}{4}$; M. $\frac{3}{3}$. Two species were described, a smaller *C. ferox*, and a larger *C. macrocephalus*, both of which have remarkably developed cranial crests. Three new species were added to the suilline division.

PLIOCENE MAN.—Special interest is attached to Prof. J. D. Whitney's recent volume upon the "Auriferous Gravels of the

Sierra Nevada," one of the official reports of the geological survey of California, though issued by the Museum of Comparative Zoölogy, because of the full description of the reported discoveries of man in the Pliocene Tertiary. These gravels are mostly consolidated into rock and are capped by lava, constituting the Table mountains. The original river valley is now completely filled by gravel and lava, so that the stream, driven out of its course, has been compelled to wear its way to depths varying from 1000 to 2000 feet on either side. Hence, the following events must have happened subsequently to the deposition of the human bones and implements in the bottom of the ancient river: (1) deposition of 130 feet of gravel over the human remains; (2) overflow of lava, completely filling up the valley, so that the river must change its course; (3) wearing down of gorges nearly 2,000 feet deep in hard slates on both sides of the lava flow, so as to carve out a flat-topped mountain. Much time must be required for the accomplishment of these results—hundreds of thousands of years, if the wearing of the Niagara gorge be taken for the unit of measurement. As glacial deposits are not known on the flanks of the Sierras, Whitney relies upon the character of the fossils exhumed to determine the age, and decides that the formation was the Pliocene Tertiary, anterior to the glacial drift of the East. The principal fossils are these: *Rhinoceros*, *Elotherium*, *Mastodon americanus* and *M. obscurus*, three species of horse, a wolf, a deer, *Hipparion*, *Auchenia*, etc. These were determined by Dr. Leidy. Lesquereux describes seventeen species of deciduous trees referred to the Pliocene, with suggestions of the Miocene. Various stone implements, including tools, pestles, mortars, platters, spear and arrowheads, are described from thirty different localities in eleven counties. Human bones were found under Table and in Bald mountain. All these facts are detailed with the utmost care, and it would seem to be clearly proved that human bones and implements are found in these gravels, associated with what are universally regarded as the fauna and flora of the Pliocene Tertiary. This is more satisfactory than any of the reported discoveries of human flints in the later Tertiary of Europe. No one would doubt the correctness of Whitney's conclusion if the question did not involve the age of man. Now, is it clear that the California Pliocene was the equivalent of the Eastern American and European Pliocene? There was no true glacial period in the Sierras corresponding to the Great Northern Drift; hence, may not the organisms of the Western Pliocene period have continued to live on till post-glacial times? Two suggestions agree with Whitney's conclusions: (1) the immense time required to excavate the deep cañons would correspond well with careful estimates of the length of the glacial period, and it is clear that man antedated the erosion of these valleys. (2) The cañon-making period in California and over the area of

the Fortietieth Parallel Survey is probably the equivalent of the glacial period of the East. It is so regarded by Clarence King, in his "Report," and was certainly subsequent to the time when the early men flourished.—*N. Y. Independent.*

The preceding abstract suggests the following observations. Some of the vertebrata reported as found with the human remains in the auriferous gravels are obviously out of place, or erroneously determined. Thus, *Elotherium* does not belong to the Pliocene fauna, nor even to the Upper Miocene (Loup Fork) but to the lowest Miocene or Oligocene (White river). *Mastodon obscurus* is Upper Miocene. How they come to be included in the list remains to be explained.

The occurrence of human implements mingled with the Pliocene fauna in Oregon, was asserted in this journal for 1878, p. 125, and some dozen species of vertebrata cited as cotemporaries. A more extended list of the mammalia was given in the Bulletin U. S. Geol. Surv. Terrs., 1879, p. 48; and of the birds in the same for 1878, p. 389. The entire number of vertebrata now determined from this locality in Oregon amounts to twenty-seven.

During the past summer the writer obtained bones of *Mylodon* from the auriferous gravels of the Klamath river, near Yreka, Cal., from excavations which he personally examined. He also obtained vessels of vesicular basalt which were undoubtedly procured from the same excavations.

The relation of this formation to the European Pliocene is discussed in an essay on the parallelism of the American and European horizons, in Hayden's Bulletin U. S. Geol. Surv. Terrs., 1879, February.—*E. D. Cope.*

GEOGRAPHY AND TRAVELS.[1]

HAYDEN'S NEW MAPS OF WYOMING, ETC.—The forthcoming reports of Dr. Hayden's Geological Survey, on the field-work of 1877 and 1878, will contain three topographical atlas sheets, of the same size, and on the same scale (4 miles to an inch) as those in the Colorado atlas. These sheets illustrate portions of Wyoming, Idaho and Utah, each of them covers 2½ degrees of longitude, and 1¼ degrees of latitude, and includes an area of about 11,000 square miles.

The south-eastern of the sheets covers the country from longitude 107° to 109° 30′, and from latitude 41° 45′ to 43°. It includes the barren plateaus of the continental divide, north of the Union Pacific R. R. The valleys of the Sweetwater and Wind rivers, and a part of the Wind River range.

The south-western sheet lies directly west of the latter, extending to longitude 112°. It embraces the Green River basin, and, farther westward, a succession of parallel ranges of no great

[1] Edited by ELLIS H. YARNALL, Philadelphia.

height, alternating with broad valleys drained by Bear river and branches of the Snake.

The third sheet lies north of the last, extending to latitude 44° 15′. Besides a small portion of the Snake River plains on its western edge, nearly all this area is occupied by rugged mountains. Among them may be noted the Tetons, the Gros Ventre and the northern part of the Wind River ranges.

The plan of the geographical work has been sketched in some detail in previous reports of this survey, and, therefore, nothing more than a brief epitome will here be attempted.

The whole work is based upon a system of triangulation, carried on with an eight inch theodolite, reading to 10″. In the scheme there were two base-lines measured, one near Fort Steele, Wyoming, the other on Bear River, in South-eastern Idaho. Each of these was between five and six miles in length. The mean error of closure of the triangles in the expansion was 5.3″. The sides ranged from twenty to seventy miles in length. Altogether, forty-nine points were located by the primary triangulation.

Secondary triangulation was carried on by a theodolite reading to minutes. The mean error of closure of secondary triangles is 3′.

The topography was secured from elevated points by map-sketches made on an assumed scale, with distances and angles estimated, and by perspective sketches, on which the topographical features were represented as they appeared to the observer at his station. All salient points in the landscape, peaks, angles of plateau, minor summits and hills, and junctions of streams, were located by intersections of sight lines from two or more stations, and in plotting the maps, in the office, the map-sketches are corrected by these locations. On these three sheets, about 3300 points, including stations, were located, being one in every ten square miles. Altogether, between 600 and 700 stations were occupied, or about one in each fifty square miles.

A few words as to the measurements of heights, and the method of construction of contour lines. Elevations were measured by means of the barometer, and the vertical circle of the theodolite. Camps, stations, and all salient points on the routes traversed, were measured by the former instrument. Aneroids were used but little and the results accepted with great caution. The vertical circle was used in determining the relative heights of all points within range of the stations—all peaks, passes, gaps, heads of spurs, etc., in short, everything that could be located, even approximately. Thus the heights of a great number of points were easily determined, and these, placed upon a perspective sketch, which may be supposed to be reasonably accurate, indicate approximately the heights of all portions of the sketch.

Difference of heights are expressed on these maps by contours. The space between two of these grade curves represents a differ-

ence of elevation of 200 feet. Where the slopes are gentle the curves are far apart, while among the cliffs of the mountains and plateaus, they are crowded together, in many places being almost run into a single line.

These curves are not "run," nor are they accurately located, as would be done in a minute survey. They do, however, express the orography, and, approximately, the elevation, over the whole map.

They are constructed mainly from the perspective sketches, aided and directed by the measured heights. As an example of the method of their construction, take a mountain spur, starting from the peak and extending to the valley below. Its summit and base, and each point of change of slope, are located, and their heights are known; we have also a profile sketch of the spur. Given these data, and what is easier than to distribute the curves with a considerable approach to accuracy, between those points actually determined.

This method of representing orography is a strictly natural one. Supposing the light to be vertical, grade curves must necessarily produce the same lights and shades as in nature. All the details of the topography, down to forms not above 200 feet in height may be expressed.

For masses for the representation of geological outcrops and formations, these grade curves are invaluable. They enable the geologist to draw accurately the outcrops not only of horizontal, but of inclined strata, over vast areas, from a few isolated observations. In many cases, by thus expressing the orography of a range, the key to its geological structure is supplied.

The maps of this Survey have been justly regarded as among the finest specimens of cartography ever published in this or any other country.

AFRICAN EXPLORATION.—Dr. Rohlf's expedition to Wadai left Bengasi on the Fourth of July, last, for the Kufara oasis. The oasis of Djâlo and Aujila were found to be ninety-eight and sixty feet respectively above the sea level. Heretofore they have been thought to be below it. At Kufara the party were attacked and plundered and obliged to return to Bengasi.——Dr. Oscar Lenz, well known for his explorations on the Ogoowé, has been sent by the German African Society to Morocco where he intends to cross the Atlas and investigate the geology and natural history of the southern districts. The Society also intends sending young travelers to this country, where they can get accustomed to Mohammedan life and become better fitted for longer journeys in Central Africa.——The *Academy* states that Mr. Donald Mackenzie has returned to England from Cape Juby, in North-western Africa, where, during his stay, many people came to enquire about trading and stated that there were numerous animals of all kinds in the interior, and the country was very fertile. Mean-

while, the French are proposing to construct a railroad across the Sahara to connect Algeria with the river Niger. The French Government has appointed a Commission to conduct preliminary investigations, and French engineers are exploring the line of the proposed road as far as the Laghouat on the south. M. Paul Soleillet will leave shortly for St. Louis, Senegal, under orders to visit the unexplored regions lying to the east of that colony as far as Timbuktu. The *Nature* states that at a recent sitting of the Paris Geographical Society, Mr. Soleillet read a paper proposing that the railroad be made from Dakkar, on the Atlantic coast, and St. Louis. The Senegal should be opened to navigation as far as Bafoulabé and a canal constructed from thence to Bamakou, on the Niger. The Niger is now navigable from Bamakou to Timbuktu and lower down for a distance of 1500 miles, The aggregate expense of the whole work is estimated at $5,000,000, and the population brought into close connection with Senegal at thirty-seven millions. These projects have been adopted by the High Commission and the survey for the canal will begin immediately. M. Soleillet believes that the semi-civilized races occupying the region he is to visit will be friendly to Europeans, and offer no obstacles to the success of this great project. The country from Senegal to the Niger is level, fertile and inhabited by two races, the Bambara and Solenké. Nothing would be easier than the establishment of a preliminary trade-road between the two rivers; it would suffice to mark out a straight line and clear it of bushes to enable a bullock-dray to travel for 200 or 300 miles. Amongst other products is a vegetable wax which can be reduced to oil, and made to serve many useful purposes in the arts.——Drs. Greef and Gasser have been despatched on a scientific mission to study the Zöology of the West African Islands.——By means of the electric light the junction of the Algerian survey with the European net-work of triangles has been completed.——One of the most important events in African exploration during the past year has been the discovery, by two Frenchmen, MM. Zweifel and Moustier, of the sources of the river Niger. Starting from Sierra Leone they ascended the Rokelle river and succeeded in crossing the Kong mountains, heretofore impassable in consequence of the hostility of the natives, and visited the heads of the three streams which, uniting after a short distance, form the Niger.

MICROSCOPY.[1]

IMPROVEMENTS IN CELL-CUTTING.—Cells cut from thin sheet wax or lead are rapidly coming into use. They can be built up one upon another to form deeper cells, but are most applicable where great thickness is not required, and have the great advantage that they can be prepared, as wanted, by anybody, of any required size, with very little trouble, and almost without

[1] This department is edited by Dr. R. H. WARD, Troy, N. Y.

expense. The elegant preparations presented by Mr. Merriman at the Buffalo meeting of the American Society of Microscopists were mounted in cells of wax cut by punches made by Mr. Wm. Streeter, of Rochester. These instruments, as subsequently improved and as now made, are represented in section by Fig. 1. There is a set of four concentric tubes of iron or hard brass, of equal length, fitting smoothly within each other, and turned to a cutting edge at the lower end. When using the punches the cutting edges are to be moistened with water to prevent sticking to the wax, and the wax laid on some book leaves or writing paper to form a firm, smooth cushion. The smallest punch is then pushed through the wax sheet with a slightly rotating motion, and then the next one is placed over it and pushed down in the same manner, and so on to the largest. The inner punch is next withdrawn by a wooden peg or pencil thrust into it, and the others drawn out one after the other by the little finger. Each ring of wax is then pushed out of its punch with the top of the next smaller punch, leaving it flat and true. The three rings thus prepared are suitable for use with cover glasses of one-half inch, five--eighths inch and three-quarters inch diameter.

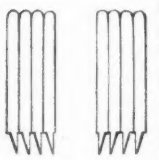
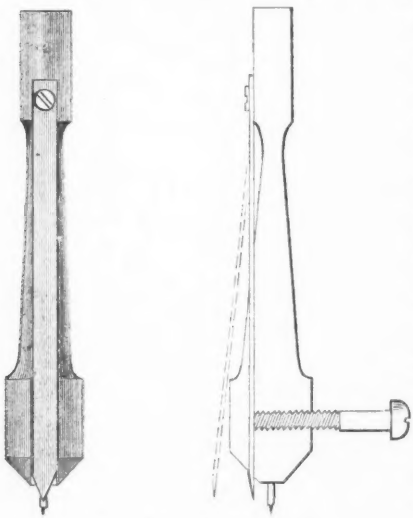


FIG. 1.—Streeter's punches.

FIG. 2.—Concentric cells as cut.

They may be fastened to the slide by a little warmth and pressure only, or by some kind of cement. Before using they should be coated, on the turn table, with shellac or other suitable cement, which will not only form a coating to the wax but also secure it to the slide. Cells thus made are very dainty in appearance, and very serviceable. The punches can be obtained by mail from Mr. Wm. Streeter, P. O. Box 73, Rochester, N. Y.



FIGS. 3, 4.—Vorce's Cutter.

Of instruments adapted to cutting both wax and sheet-lead cells, two very convenient forms were brought forward by Dr. R. H. Ward, at a recent meeting of the Troy Scientific Association. The first was designed by Mr. C. M. Vorce, of Cleveland, O., and

is represented in front view and in section in Figs. 3 and 4. It can be readily made by amateurs for their own use. It consists of a wooden body of such size as to be easily held and twirled between the fingers, with a short needle point inserted in the center of the lower end. On one side a longitudinal slot or groove is cut through the wood deep enough to allow the cutting edge to approach nearly to the needle. The cutter is of steel, one-eighth or three-sixteenths inch wide, as a piece of skirt-steel or corset-spring, and is attached so as to lie in the groove and press toward the needle. The cutter should be ground to a triangular point, and ground only on the outside, leaving its inner face flat and smooth. A screw passes through the body of the instrument and bears against the spring, regulating its distance from the needle point. Greater firmness might be secured by changing the form of the body so as to support at its two edges the cutter when forced out to its farthest limit. The other instrument, shown in Fig. 5, was suggested by the Vorce instrument, and was contrived by Mr. Frank Ritchie, of Troy. It possesses greater power and precision than the other, but is not so easily made by an amateur. It consists of a pair of spring dividers about three and one-quarter inches long, from one leg of which half an inch of its length has been cut off and replaced by a brass socket with a binding screw to hold a small knife blade. A knob is also added at the top for convenience in manipulation. The method of working these two forms of apparatus is precisely the same. A sheet of wax may be laid on a sheet of heavy white paper, and both together tacked to a piece of smooth hard wood. The instrument with its legs set three-sixteenths inch apart, is used to cut out a series of discs of three-eighths inch diameter. How near together these can be safely cut will soon be learned by experience. The legs are then set one-quarter inch apart, and using the same centers as before, a series of rings can be cut suitable for one-half inch covers. By successively spreading the legs one-sixteenth inch further each time, rings may be cut around the same centers for five-eighths and three-quarters inch covers, and larger if desired. The concentric rings around each center are cut out without waste, as shown in Fig. 2. Not only wax but also sheet-lead, card-board and gutta percha can be cut with facility in this manner. The various tools sold by hardware dealers for cutting washers of leather, etc., have often been employed for this work, but they have proved too clumsy to be useful.

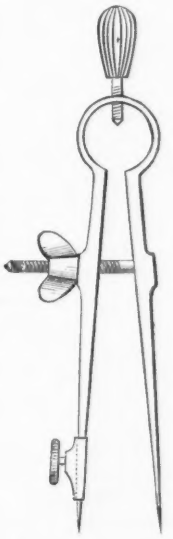


FIG. 5. — Ritchie's Cutter.

ANOTHER JOURNAL.—A successor to the late *American Quarterly Microscopical Journal* is announced, in the form of a monthly by the same editor, and in a more popular form. The first number is promised for the present month. The editor's name is a sufficient guarantee of the scientific spirit and energetic management of the new enterprise, which can scarcely fail, and ought not to fail, at the low subscription price of one dollar a year, to receive so general a support as to become self-sustaining and permanent. It is published by Romyn Hitchcock, at 51 Maiden Lane, N. Y.

ADULTERATIONS IN FOOD.—The prize offered last summer for the best two slides illustrating the adulteration of some common article of food, one slide to show the genuine article and the other to show an adulterated form actually sold and used, will be awarded at the meeting of the American Society of Microscopists, next summer. The donor, Mr. E. H. Griffeth, will substitute for the medal promised an objective suitably engraved, if preferred by the winner.

EXCHANGES. — Fine diatoms and other marine material for named diatoms, diatomaceous earths or other good mounted objects.—M. A. Booth, Longmeadow, Mass.

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SCIENTIFIC NEWS.

— In the *American Journal of Science and Arts* for December, Prof. James D. Dana, the editor, and who is, we need not remind our readers, one of the leading geologists of his time, reprints the bill for the establishment of the U. S. Geological Survey of the Public Domain, and adds his weighty comments on the "unexpected amendment" to this bill introduced by Mr. King, the geologist-in-charge, and passed by Congress at the extra session, by which the survey is extended over the whole area of the United States, including the States as well as the Western Territories. Prof. Dana observes that the amendment was not even "presented for public discussion, although it bears on the political and industrial interests of the country, as well as on the status of science under the General Government." Prof. Dana then adds that "Having been a member of the National Academy, the writer has felt it a duty here to state, that this proposed expansion of the field of work under the 'Director of the Geological Survey' is wholly foreign to the views expressed in the Report of the Committee, and to the opinions brought out in their discussions. Moreover, it is entirely at variance with the objects set before the committee by the Act of Congress requiring its appointment: this act asking that the members 'take under consideration the methods and expenses of conducting all surveys of a scientific character under

the War or Interior Department and the surveys of the Land Office, and to report to Congress as soon thereafter as may be practicable, a plan for surveying and mapping the Territories of the United States on such general system as will, in their judgment, secure the best results at the least possible cost.' The plan set forth by the committee, besides having direct reference to the Territories, had in view that economy of expenditure, suggested in the act of Congress; while the new scheme, with the proposed enlargement of its scope, would involve—as State geological surveys have shown—millions of outlay for the strictly geological part, and indefinite millions besides for the economical branch—the study of 'the mineral resources and products of the National Domain,' '*and the States*.'

"The writer is not informed as to the character of the discussion over the proposed amendment in the House of Representatives. But it seems to be plain, from the change of wording, that the meaning intended to be conveyed by it was that the director 'may extend his examination into States' *which adjoin Territories*. There is an evident absurdity in an expression which adds the States—nearly the whole country—to the Territories. Had the general survey of the United States been intended by the House, the idea would have been brought out by the simple substitution of the words United States for 'National Domain.' "

Prof. Dana also adds: "A change so great in the administration of the affairs of the Government should have a full discussion before it is accepted. It will appear to many that the Constitution has left to the States the making of their own geological surveys and the study of their own economical resources—as past history seems to attest—and that such an infringement on State rights and assumption of State responsibilities would be politically wrong; and also, that investigations into the mineral resources of the States, whether of a mine or of a granite quarry, would be followed by other evils through encroachments on private rights, and the temptations to favor private enterprises. The General Government, unlike many in foreign lands, has no ownership in the mines of California or of any other of the States, and hence has no need to establish a Mining Bureau for the country at large."

Coming from the source it does, this is a weighty protest, and is in the line of criticism adopted by this journal.[1] While the U. S. Geological Surveys under Hayden, Powell and the U. S. Engineers, Lieut. Wheeler in charge, were confining their attention to developing our knowledge of the natural resources of the Western Territories, with excellent results already accomplished and with a great mass of unpublished material for valuable final reports which will now probably never see the light; all this was

[1] AMERICAN NATURALIST, May, 1879, p. 343, August number, p. 535.

not only interrupted, but stopped, through the unwise action of a handful, not of politicians, but scientists. The result has proved, we fear, that it would have been better to have let well enough alone, for during the past season little or no geological exploration has been carried on in the Western Territories; small parties were sent to Leadville and the Eureka mines and the Comstock lodes and the California gold fields, no general geological work having, apparently, been done at all! The people want and are expending money for more information about the unsurveyed lands of the Far West; the scientific world demand and should have widely extended and thorough topographical, geological and biological surveys of that vast region, such as have been inaugurated and carried on in the past; these, as we have always felt should be directed by one mind, and for this reason some members of the National Academy voted for the consolidation of the different surveys then in the field. For a United States Survey of the Public Lands to expend a large or moderate proportion of its money and means in one or several of the Eastern States, such as Tennessee, or one of the New England States, is absurd and uncalled for, and interferes with the work that may be going on or is in prospect in such State. American scientists hope and expect that geological explorations under the new *regime* will, hereafter at least, not be inferior in breadth of treatment, scientific accuracy and extent, to what it has been in the past; certainly that the zeal and previous success in field and general geological work of the Geologist of the Fortieth Parallel may not be lessened, but fulfill the expectations of the American people and scientific public.—*Editors Naturalist.*

— Prof. B. F. Mudge, formerly Mayor of Lynn, Mass., died in Kansas on Friday last. Mr. Mudge was born at Orringford, Me., August 11, 1817; his parents removed to Lynn when he was about a year old. He attended the common schools until he was 14 years old, when he went to work at shoemaking, at which he worked six years. Then fitting for college he entered Wesleyan University, where he graduated in 1840, subsequently taking up the study of law. In 1842 he was admitted to the bar and practiced his profession at Lynn until 1859. He was elected the second mayor of Lynn, serving in 1852 and 1853. He went West and became chemist for the Breckinridge Oil and Iron Company of Kentucky. When the war broke out he went to Kansas, and in 1863 was appointed State Geologist. In 1865 he was elected Professor of Geology and Associated Sciences at the State Agricultural College, and remained in that position for eight years. Since 1874 Mr. Mudge has been employed in exploring the geological formations of Western Kansas. He was also employed by Dr. Hayden in describing the tertiary and cretaceous formations in Kansas, and he made extensive collections for Prof. E. D. Cope, in that State, during which he discovered the first specimens of

toothed birds. Prof. Mudge spent the greater part of his later years in camp life beyond the settlements in the employ of Prof. Marsh as field geologist for Yale College. He was a member of the American Association for the Advancement of Science, and of other scientific bodies, and was instrumental in founding the Kansas Academy of Sciences, of which he was the first president. In 1876 the office of State Superintendent of Public Institutions was offered him, but he preferred to continue his field work. In 1846 Mr. Mudge married Miss Mary E. A. Beckford, of Lynn. Six children were born to them, of whom three are still living.

— During his voyage near Behring Straits, Professor Nordenskiöld obtained numerous remains of Steller's manatee, of which only a few bones have hitherto existed in the St. Petersburg Museum. This large Sirenian, it will be remembered, became extinct in 1786.

— The death of A. H. Garrod, F.R.S., Oct. 17th, at the age of thirty-four, is announced in the English papers. He was making an excellent reputation as a comparative anatomist and physiologist.

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PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Kansas Academy of Sciences, Twelfth Annual Meeting.—Prof. B. F. Mudge, the president of the academy, lectured on the mound-builders of America. Papers were read by the president on the metamorphic deposits in Woodson county, and on Indian mounds in Davis and Riley counties, also by Dr. A. H. Thompson on Indian graves near Topeka. The report of the Commission on Botany was read by Prof. J. H. Carruth, who announced the discovery of about 120 species new to the State. A paper was read by Hon. F. G. Adams, of Topeka, on the phonetic representation of the Indian language, describing the systems or alphabets invented by the Cherokee, Sequoyah, and by Mr. Meeker, a missionary who formerly resided in Johnson county. The alphabet formed by Mr. Meeker was said to be adequate to the perfect phonetic representation of any Indian language, and books were printed in the characters of that alphabet in eleven different dialects.

Boston Society of Natural History, Nov. 5th.—Mr. W. O. Crosby spoke on the Evidences of Compression in the Rocks of the Boston basin, and Mr. J. W. Feukes on *Aoyla pentagona*, and its relation to a theory of bilateral symmetry. Nov. 19th.—Mr. Ernest Ingersoll read a brief survey of the native oysters of Massachusetts. Prof. A. Hyatt spoke on some remarkable changes undergone by fresh water snails (*Lymnæa megasoma*) in captivity, as observed by Mr. A. P. Whitfield. Dec. 3d—Mr. J. S. Diller remarked on the felsites and their associated rocks north of Boston.

APPALACHIAN MOUNTAIN CLUB, Nov. 12. — The councillors reported as follows: Mr. J. R. Edwards on topography, Prof. C. E. Fay on exploration and Dr. W. B. Parker on improvements. Rev. John Worcester described the excursion to Tuckerman's ravine, made in connection with the field meeting at North Conway. Prof. Charles R. Cross gave an account of the Congress of Alpine clubs, held at Geneva the past summer, which he attended as the representative of the club.

Dec. 10.—Prof. J. H. H. Huntington reported as councillor of natural history. Mrs. Phebe M. Kendal presented her report as councillor of art. Prof. E. S. Morse read some notes on Japan, illustrated by the large maps of Japan recently received by the club. A copy of Prof. Guyot's new map of the Catskill mountains, presented by the author, was shown and an explanatory paper, written by him, was read.

AMERICAN GEOGRAPHICAL SOCIETY, Nov. 18.—The Earl of Dunraven read a paper on moose and caribou hunting in the wilds of Canada. Dec. 9.—Rear Admiral Ammen presented a paper on the proposed inter-oceanic ship canal across Nicaragua.

NEW YORK ACADEMY OF SCIENCES, Section of Biology, Dec. 1. —Prof. Geo. Macloskie read a paper on the proboscis of the house fly.

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SELECTED ARTICLES IN SCIENTIFIC SERIALS.

AMERICAN JOURNAL OF SCIENCE AND ARTS, Dec. 15th—Artificial fertilization of oyster eggs, and embryology of the American oyster, by W. K. Brooks. Origin of the Lœss, by G. C. Brodhead. New Jurassic reptiles by O. C. Marsh.

GEOLOGICAL MAGAZINE, Nov.—Further notes upon the form of volcanoes, by J. Milne.

JENAISCHE ZEITSCHRIFT FÜR NATURWISSENSCHAFT, Oct. 29—On the comparative anatomy of the digestive system of birds, second part, by H. Gadow. The distribution of the fresh and brackish water fishes of Africa, by C. Dambeck. The anatomy and histology of the actinians with special reference to the nervo-muscular system, by O. and R. Hertwig.

SIEBOLD UND KÖLLIKER'S ZEITSCHRIFT FÜR WISSENSCHAFTLICHE ZOOLOGIE, Oct. 29th—Researches on the structure and development of sponges, eighth part, by F. E. Schultze. Germ layers and formation of the organs of Echini, by E. Selenka. Contributions to the natural history of the *Daphnidæ*, by A. Weismann.

ANNALES DES SCIENCES NATURELLES, Sept., 1878 (just received) —On the scales of teleosaurian fishes, by M. Carlet. On the geographical distribution of bats compared with that of other terrestrial mammals, by M. Trouessart.